NSF-ATM 0349356 Project

CAREER: A research and education program in Dynamical Paleoclimatology

Report 2005

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1. Introduction

This report concerns to those activities development in Peru as a part of NFS-ATM 0349356 project **CAREER: A research and education program in Dynamical Paleoclimatology** funded by the National Science Foundation (NSF). These activities were developed thought July 2005.

2. Objectives

One of the main goals of this project is development of new proxy rainfall data from replicated, high-resolution stable isotope measurements made on tropical trees. One region targeted to accomplish with this goal is the northwest coastal Peru (5 S, 80 W).

3. Northwest coastal Peru

The northern coast of Peru is located between about 3° and 7° of South latitude and it is westernmost coast of South-America.” It is relatively flat and wider than rest of Peruvian coast, extending about 140 km from the Pacific Ocean to the western slope of the Andean cordillera.

In this region is located the Sechura desert between 6° and 7° of South latitude and with 3,000 kilometer square in extension. The flat area is interrupted by a short north-east placed chain of hills called “Cerros de Amotape” located at about 4° of South latitude. This coastal line contents the westernmost point of South-America (Balcones Point).

Three major transverse rivers which flow through fertile valleys, on coastal area, from the west side of the Andes to the Pacific Ocean. In order from North to South these rivers are Tumbes (permanent), Chira (permanent) and Piura (seasonal).

The climate of lowland of northern coast of Peru is normally hot and dry. El Niño-Southern Oscillation (ENSO) is the main climatic variability that affects this region. This region is direct exposes to effects of such climatic variability. Maybe none area of World is affected in such form as on the northern coast of Peru. The climate of this region alters between dry years (normal years) to very wet years with heavy rain (ENSO years) about two ENSO events by each decade.

Such climate change impact strongly on the marine and terrestrial ecosystems of this region. The impact on the ecosystem is reflected in change of the dry forest into a very wet forest, with all species plenty of green. The dry forest of this region gets almost as impenetrable jungle.

This climatic variability has been recorded in the tree-rings of some typical species of this region (Rodriguez, 2005).

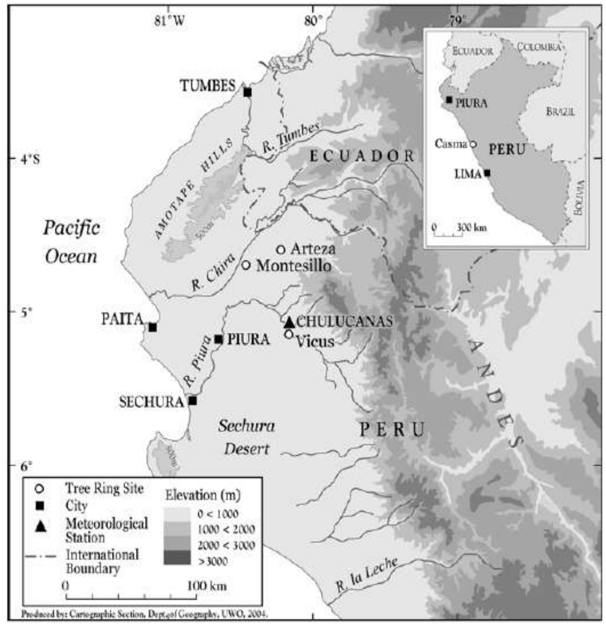


Figure1. Map of northern coast of Peru. This coastal area is wider than rest of Peruvian coast (Rodriguez, 2005).

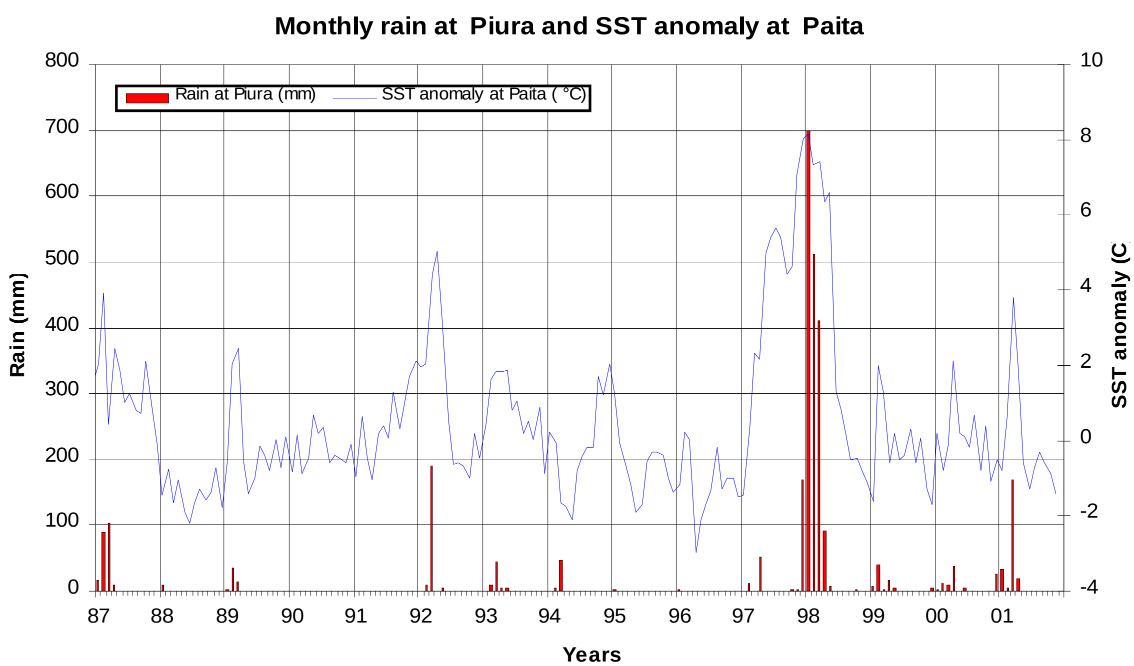


Figure 2: Monthly variation of Sea Surface Temperature anomaly at Paita, Piura and the concerns rains felt down at Piura city. The annual average of these rains is between 50 to 100 mm but when an ENSO event occur this average can be more than 1000 mm. In this figure we can see the climate alteration of Piura area due to the ENSO events of 1987(weak), 1992(weak) and 1998 (strong).

4. **Typical species in the region**

In order to carry out with the specific goal of this project in Peru we have collected the names of all botanical species of that region. The dry forests of northern coast of Peru and southern coast of Ecuador are parts of the Tumbesina equatorial dry forest characterized by great number of endemic botanical species (Best, 1992). The appendix A lists the main botanical species northwest coastal of Peru and southern one of Ecuador.

5. **Field work in Peru**

A preliminary corers sampling was done in November 2002. In this campaign we identified some tree species and sites with potential to get a new proxy record. (Evans, 2002)
Since the dry forest of northern coast of Peru and southern coast of Ecuador form part of Tumbesina ecological region and it is so sensible and affected by the El Nino- Southern Oscillation (ENSO) phenomenon we expand the sampling work to southern Ecuadorian.
In June 2004 we did a sampling campaign in this region. The table 1 summaries the sites and trees sampled. In this campaign we collected 288 corers.

Table1. Sites and trees sampled in June 2004 along northern coast of Peru and southern Ecuador.

It.	Code	Sites	Country	Latitude (S)	Longitude (W)	Altitude (mosl)	Tree species sampled	No Samp.
1	TA	Angostura	Peru	3° 46.132'	80° 20.635'	73m	Hualtaco, Pasallo, Ebano	30
2	PU	Puyango	Ecuador	3° 52.872'	80° 05.495'	310m	Hualtaco Blanco, Pretino	14
3	LC	Laipuna	Ecuador	4° 12.649'	79° 53.191'	574m	Pasallo, Palo Santo	24
4	RP	Rica Playa	Peru	4° 14.854'	80° 54.473'	79m	Hualtaco, Pasallo, Palo Santo	34
5	LB	La Breita	Peru	4° 14.854'	80° 54.473'	226m	Hualtaco	11
6	RC	La Ceiba	Ecuador	4° 15.753'	80° 19.290'	509m	Hualtaco, Pasallo, Polo Polo, Ceibo	27
7	MA	Maivas	Ecuador	4° 19.566'	80° 17.585'	281m	Palo Santo	8
8	EA	El Alto	Peru	4° 22.730'	81° 08.740'	187m	Hualtaco	20
9	CC	El Angolo	Peru	4° 25.662'	80° 45.880'	525m	Hualtaco, Pasallo, Palo Santo	44
10	LL	Las Lomas	Peru	4° 35.395'	80° 14.285'	589m	Hualtaco, Pasallo, Palo Santo	20
11	MO	Montesillo	Peru	4° 41.000'	80° 27.000'	133m	Hualtaco, Palo Santo	11
12	CV	Cerro Vicus	Peru	5° 09.000'	80° 10.000'	250m	Palo Santo	12
13	CB	Cerro Blanco	Peru	5° 23.222'	79° 48.848'	191m	Hualtaco, Pasallo, Ceibo	20
14	LT	La Traposa	Peru	6° 25.200'	79° 33.938'	193m	Hualtaco, Palo Santo	22
15	CH	Chilete	Peru	7° 14.330'	78° 50.212'	962m	Hualtaco, Palo Santo	14

On May 20-21, 2005 an two-days sampling campaign was conduced by professor Rodriguez in the Petrified forest Puyango on southern of Ecuador located between provinces of El Oro and Loja. In this campaign, a larger borer was used to sample larger corers and it was collected 24 corers of Pretino, Pasallo Blanco y Polo Polo. The table 2 is an inventory of the corers that we sampled.

Table2. Inventory of tree corers sampled of the Puyango Petrified Forest, (Ecuador), on May 2005.

Tree corers sampling inventory
Date: May 20- 2, 2005
Site: Bosque Petrificado Puyando
(Site code: PU)
Provinces: El Oro and Loja. (Ecuador)
(Lat: 03° 52.872'S, Lon: 80° 05.495W', Alt: 310m)

It.	Specie	Type	Samp.ID.	Per(cm)	Hei(cm)
1	Laurel	Corer	PU1.1	101	106
2	Pretino	Corer	PU2.1	568	135
3	Pretino	Corer	PU2.2	568	109
4	Pretino	Corer	PU3.1	438	117
5	Pretino	Corer	PU3.2	438	110
6	Polo Polo	Corer	PU4.1	190	96
7	Pasayo Blanco	Corer	PU5.1	150	96
8	Pasayo Blanco	Corer	PU5.2	150	110
9	Pretino	Corer	PU6.1	346	108
10	Pretino	Corer	PU6.2	346	134
11	Polo Polo	Corer	PU7.1	198	109
12	Pretino	Corer	PU8.1	405	130
13	Polo Polo	Corer	PU9.1	117	113
14	Polo Polo	Corer	PU9.2	117	124
15	Pretino	Corer	PU10.1	538	138
16	Pretino	Corer	PU10.2	538	135
17	Pretino	Corer	PU11.1	315	120
18	Pretino	Corer	PU11.2	315	90
19	Pretino	Corer	PU12.1	510	141
20	Pretino	Corer	PU12.2	510	135
21	Polo Polo	Corer	PU13.1	110	42
22	Polo Polo	Corer	PU13.2	110	37
23	Polo Polo	Corer	PU14.1	110	45
24	Polo Polo	Corer	PU14.2	110	38

All these samples were carried on July 2005 to LTRR to be analyzed.

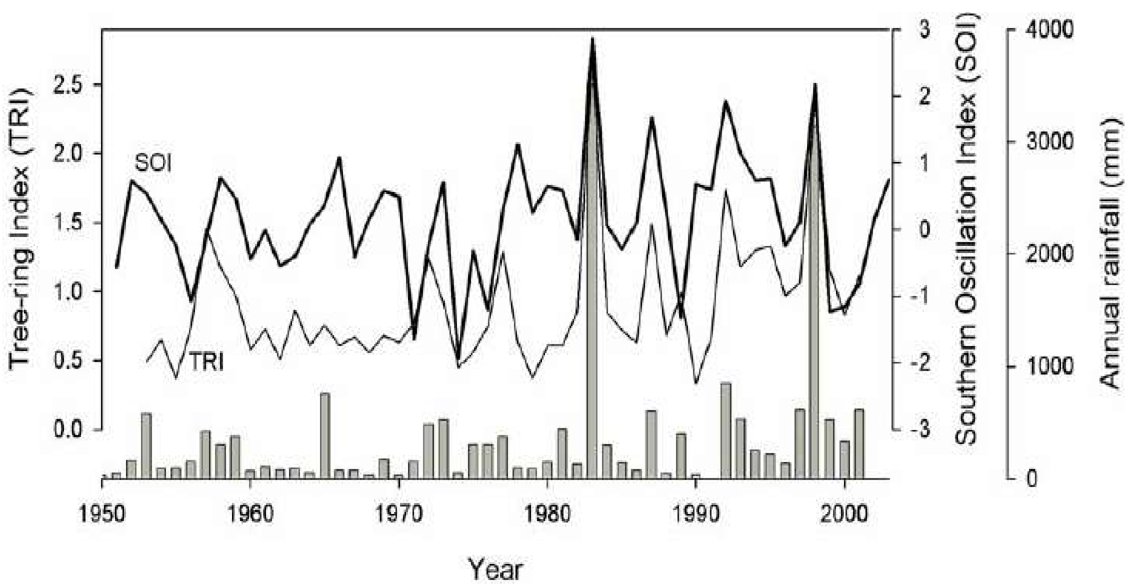
6. Laboratory work

These samples are being analyzed in both Laboratory of Tree-ring research (LTRR) of University of Arizona at Tucson and the Laboratory of Tree-ring of Universidad de Piura (Peru).

7. Results

- **Tree-ring width series**

The first short tree-rin chronology developed was for Palo Santo from Vicus Hill close to Chulucanas in Piura, Peru. This series was 38 years long (1954-2001) based on 23 cores and showed the record of two last major ENSO events (1982-83 and 1997-98) as wide rings in almost all cores sampled (Rodriguez, 2000).
That first series was extended the spatial network and length of Palo Santo chronologies across the region. Chronologies for Montesillo (1953-2001) and for Arteza Hills (1967-2000) show similar results to those from Vicus Hill. A composite chronology from these three series clearly shows an ENSO signal with an average recurrence period of about 5 years. This composite chronology has a positive correlation of 0.84 (n=49, $P<0.001$) with annual precipitation. The correlation coefficient of the log-transformed series is somewhat less but still highly significant (r=0.73, n=49, $P<0.001$). A statistically significant negative correlation of -0.54 (n=49, $P<0.001$) was also found with a mean November-April Southern Oscillation Index (SOI, Ropelewsky and Jones, 1987) as is shown in the figure 3.



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8.

Since Dr. Michael N Evans got a faculty small grant proposal to mount a sampling expedition to the lowland dry forest of northwestern coastal Peru in June 2002, a stretch collaborative work began between Universidad de Piura and the Laboratory of Tree-ring research (LTRR). The NSF Project ATM 03-49356 has increased this cooperation in both education and research activities. Some presentations, publications and activities have been done based in this collaborative work.

- **Work visiting**

On June 2004 Visit of Dr. Michael N Evans to University of Piura to take part of the sampling campaign thought northern coast of Peru and southern Ecuador.

In this visit Dr. Evans gave an oral presentation on "Tropical Isotope Dendrochronology" to professors and student of Engineering Faculty of Universidad de Piura.

On July 2005 M Sc. Rodolfo Rodriguez visited the Laboratory of Tree-ring research (LTRR) of University of Arizona at Tucson, AZ.
In this visit Professor Rodriguez gave an oral presentation on " Dendrochronological research with lowland species of northern coast of Peru and southern Ecuador: Records of ENSO events to students and researchers of LTRR.

- **Educational support**

On January 2005 the NSF-ATM 0349356 project support to three Peruvian students to part the Third South American Field week of Dendrochronolgy held in Mato Groso, Brasil. These students were Becky Garcia Calle, Juliana Adanaque Benites and Rodrigo Galecio Sosa of the Engineering Faculty of Universidad de Piura (Peru).
Through the Tree-ring Lab of University of Piura it was advised that an Ecuadorian student from Universidad de Loja (Jose Oswaldo Benites) take part also of this Field week.

On May 2005 professor Rodolfo Rodriguez and two students (Becky Garcia Calle and Vanessa Sanchez Pajuelo) of Universidad de Piura received financial support to take of the First Internacional Conference on El Nino and its global impacts, held in Guayaquil (Ecuador) on 16 – 20 May, 2005 and also to do two days sampling campaign of width trees, using a large borer, in the Petrified forest Puyango on southern of Ecuador.

- **Equipment**

On March 2005 a large borer from LTRR was sent to Tree-ring of Universidad de Piura to be used in sampling of width trees.

On July 2005 a motor drill was bought to sampling work of hard wood of some Peruvian species such as Algarrobo (or Mesquite) which is a tree specie with potential for the isotope dendrochronology studies.

- **Oral and poster presentations in scientific meetings**

Dendrocronologia con especies del bosque seco del noroeste de Perú. By Rodolfo Rodríguez, Antonio Mabres, Elizabeth Cordova, Juliana Adanaque, Mery Gomez, Alejandro Saavedra, Ronald Woodman, Brian Luckman and Michael Evans. An oral and poster presentation in the First Internacional congreso of dry forest, Piura (Perú), November 2003.

Estudios dendrocronologicos en Peru. Potencial Dendrogeomorfologico. By Rodolfo Rodríguez, Antonio Mabres, Brian Luckman y Michael Evans. A poster presentation in the XII Congreso Peruano de Geología, Lima (Perú), October 2004.

Dendrochronological records of "El Niño" events in the low land of northwest Peru and of southern Ecuador. By Rodolfo Rodríguez, Antonio Mabres, Ronald Woodman, Brian Luckman y Michael Evans. A poster presentation in the First Internacional Conference on El Nino and its global impacts, held in Guayaquil (Ecuador) on 16 – 20 May, 2005.

- **Publication**

" El Niño" events recorded in dry-forest species of the lowlands of northwest Peru. By Rodolfo Rodríguez, Antonio Mabres, Brian Luckman, Michael Evans and Mariano Masiokas. A paper accepted for publication in Dendrochronologia, 2005.

9. References

Best, B., 1992, The threatened forest of south-west Ecuador. 240 p.

Evans, M. N. and D.P. Schrag, 2004: A stable isotope-based approach to tropical dendroclimatology, Geochim. et Cosmochim. Acta, 68(16), 3295-3305

Evans, M. N 2002. Tracking ENSO with tropical trees: Progress in stable isotope dendroclimatology, AGU, 2002.

Rodriguez, R., 2002, Dendrochronological studies of El Niño events and other climatic variations in the Tropical Zone of South America, (IAI CRN03 Scientific Progress Report, 2001-2002, Peru). In Luckman, B. H. (ed) 2002 IAI CRN03 Annual Report 2002. Submitted to the IAI, Brazil, November 2002; p74-84.

Rodriguez R. at el, 2005. "El Niño" events recorded in dry-forest species of the lowlands of northwest Peru. A paper accepted for publication in Dendrochronologia, 2005.

Ropelewski, C.F. and Jones, P.D., 1987, An extension of the Tahiti-Darwin Southern Oscillation Index. Monthly Weather Review 115, 2161-2165.

Appendix A1: List of main botanical species of northern coast of Peru in Tumbes and Piura area. Sources: (1) Mapa de Bosques Secos del Departamento de Piura: Memoria Descriptiva, INR-82-DGEO and (2) INRENA, Lima - Peru, 1998).

Common Name	Scientific Name	Family

TREES

Algarrobo	*Prosopis sp.*	Leguminosae
Almendro	*Geoffroya striata.*	Leguminosae
Angolo	*Pithecellobium multiflorum*	Leguminosae
Analque	*Coccoloba ruiziana*	Polygonaceae
Barbasco	*Piscidia carthagenesis*	Leguminosae
Ceibo	*Ceiba trischistandra*	Bombacaceae
Cerezo	*Muntingia calabura*	Elaeocarpaceae
Corona de Cristo	*Cercidium praecox*	Leguminosae
Chapra	*Leucaena trichodes*	Leguminosae
Charan	*Caesalpinia paipai*	Leguminosae
Diente de Leon	*Scherebera americana*	Oleaceae
Ebano	*Ziziphus thyssiplora*	Rhamnaceae
Faique	*Acacia macracantha*	Leguminosae
Frejolillo (Suno, Venturo)	*Erythrina Smithiana*	Leguminosae
Guayabilla	*Psidium sp*	Mirtaceae
Guayacan	*Tabebuia crysantha*	Bignoniaceae
Higueron	*Ficus padifolia*	Moraceae
Hualtaco	*Loxopterygium Huasango*	Anacardiaceae
Huapalo	*Sickingia tinctoria*	Rubiaceae
Huarapo	*Terminalia valverdaceae*	combreataceae
Limoncillo	*Ximenia americana*	Olacaceae
Madero	*Tecoma sp*	Bignoniaceae
Oreja de Leon	*Centrolobium sp (Alseis peruviana)*	Rubiaceae
Palo Blanco	*Celtis triflora*	Ulmaceae
Palo Santo	*Bursera graveolens*	Burseraceae
Palo verde	*Parkinsonia aculeata*	Leguminosae
Pasallo	*Eryotheca ruizii*	Bombacaceae
Pata de vaca	*Bauhinia aculeata*	Leguminosae
Pego Pego	*Pisonia macracantha*	Nyctaginaceae
Polo Polo	*Cochlospermum vitifolium*	Choclospermaceae
Porotillo - Margarito	*Capparis eucalyptifolia*	Capparaceae
Sapote	*Capparis angulata*	Capparaceae

ARBUSTOS

Aromo	*Acacia Huarango*	Leguminosae
Borrachera	*Ipomoea carnea*	Convulvulaceae
Cardo Azul	*Armatocereus oligogonus*	Cactaceae
Cardo Madero	*Armatocereus cartwrightianus*	Cactaceae
Cun Cun	*Vallesia glabra*	
Charamusco	*Encelia canescens*	
Giganton	*Neoraimondia gigantea*	Cactaceae
Mata Burro	*Parkinsonia aculeata*	
Overal (Overo)	*Cordia lutea*	Borraginaceae
Palo Negro	*Grabowskia boerhaviifolia*	Solanaceae
Papelillo	*Bougainvillea pachyphylla*	Nyctaginaceae
Quirquinche (Chaquiro)	*Pithecellobium excelsum*	Leguminosae
Vichayo	*Capparis ovalifolia*	Capparaceae

Satuyo	*Capparis cordata*	Capparaceae
HIERBAS		
Jabonillo	*Luffa operculata*	
Yuca de Caballo	*Proboscidea altheaefolia*	
Yuca de Monte	*Apodanthera biflora*	

Appendix A2: List of main tree species of southern coast of Ecuador in Loja area.

Sources: (1)Estudios Botanicos en el Sur de Ecuador, Herbario Loja No 3, Febrero 1999, Departamento de Botanica y Ecologia, Universidad de Loja and (2) Gonzales E., Garcia J. C., Correa J. Especies Forestales del Bosque seco Cerro Negro - Cazaderos, Zapotillo-Puyango-Loja, Ecuador, Fundacion Ecologica Arco Iris. Loja Ecuador.39 p., 2005

Common	Scientific Name	Family
ARBOLES		
Algarrobo	*Prosopis Juliflora*	Mimosaceae
Almendro (Seca)	*Geoffroea spinosa*	Fabaceae
Amarillo	*Centrolobium ochroxylum*	Fabaceae
Angolo	*Albizia multiflora*	Fabaceae
Analque	*Cocoloba ruiziana Lindau*	Polygonaceae
Balsa (Palo de Balsa)	*Ochroma pyramidale*	Bombacaceae
Balsamo	*Myroxylon balsamun*	Fabaceae
Barbasco	*Piscidia carthagenensis Jacq*	Fabaceae
Ceibo	*Ceiba Trichistandra*	Bombacaceae
Cerezo	*Muntingia sp*	Blasocarpaceae
Charan	*Caesalpinia Corymbosa*	Caesalpinaceae
Chereco	*Sapindus saponaria*	Sapindaceae
Ebano	*Ziziphus thyssiplora*	Rhamnaceae
Faique	*Acacia Macracantha*	Mimosaceae
FernanSanchez	*Triplaris cumingiana*	Polygonaceae
Guarapo	*Terminalia valverdeae*	Combretaceae
Guayacan	*Tabebuia chrysantha*	Bignoniaceae
Hualtaco	*Loxopterygium Huasango*	Anacardiaceae
Huapala	*Simira ecuadorensis*	Rubiaceae
Mata Palo	*Ficus jacobii*	Moraceae
Palo Ajo	*Gallesia Integrifolia*	Phytholaccaceae
Palo Santo	*Bursera graveolens*	Burseraceae
Pasallo	*Eryoteca ruizii*	Bombacaceae
Pego Pego	*Pisonia aculeatada L.*	Nyctaginaceae
Polo Polo	*Cochlospermun vitifolium*	Bixaceae
Porotillo	*Erithryna velutina*	Fabaceae
Pretino	*Cavanillesia platanifolia*	Bombacaceae
Sapote	*Capparis Angulata*	Capparidaceae
ARBUSTOS		
Borrachera	*Ipomoea carnea Jacq*	Convolvulaceae
Buganvilla	*Bouganvillea peruviana*	Nyctaginaceae
Overal	*Cordea lutea*	Boragginaceae