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## **Biological control of bellyache bush: Native range surveys in South America**

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## Abstract

Bellyache bush (*Jatropha gossypifolia*), a deciduous shrub introduced as an ornamental from tropical America, is a major and expanding weed of rangelands and riparian zones in northern Australia. Biological control that complements existing control techniques (e.g. herbicide, mechanical and fire) is needed for cost-effective and long-term control of the weed. Surveys in Mexico, Central and northern South America and the Caribbean for potential biological control agents resulted in release of the seed feeding bug *Agonosoma trilineatum* (which failed to establish) and prioritisation of a leaf-rust *Phakopsora arthuriana* (previously known as *P. jatrophicola*) for host-specificity testing (ongoing). Prospects of gaining new agents from Mexico, Central America and the Caribbean are unlikely. Hence, further surveys were conducted in South America, at 42 sites in Peru, 15 sites in Bolivia and 16 sites in Paraguay. Natural populations of bellyache bush (green leaf form) were seen only in the arid regions of Bolivia. Ornamental populations (purple leaf form) were seen in Peru, Paraguay and Bolivia. A total of 14 agents (12 species of insects, one mite species and one rust fungi) were collected from Peru, Bolivia and Paraguay. The insects were exported to a quarantine facility in South Africa, where they were reared through to adults and sent to relevant taxonomic experts for identification. Identifications of the leaf-mining gracillariid moth *Stomphastis thraustica* from Bolivia and Peru and the leaf-feeding cecidomyiid *Prodiplosis* sp. near *longifila* from Paraguay have been confirmed, while the identification of the shoot-tip/leaf galling cecidomyiid (?*Prodiplosis* sp.) from Bolivia is in progress. None of the notodontid larvae from Paraguay developed into adults in the quarantine facility in South Africa. A leaf-rust was also recorded from both Bolivia and Peru. The leaf was exported to CABI (UK) and DAFF (Brisbane) where it was identified as *P. arthuriana*. The limited number of insect species found on bellyache bush in the arid regions in Bolivia was probably due to the timing of surveys which were undertaken late in the dry season. Further exploration needs to be conducted in Bolivia during the wet season to study the field host range and damage levels of the previously identified agents and to look for any new agents. Based on the restricted field host range in South America, an application to import the *Jatropha* leaf-miner (*S. thraustica*) in to a quarantine in Brisbane, Australia for host-specificity testing has been submitted to relevant regulatory authorities in Australia.

## Executive summary

A trip to South America was undertaken to conduct surveys in Peru, Bolivia and Paraguay for potential biological control agents for bellyache bush (*Jatropha gossypifolia*) a serious weed of Queensland and a Weed of National Significance in Australia.

In Peru, surveys were conducted across 42 sites in Tarapoto and Iquitos regions. All *J. gossypifolia* populations surveyed were of purple-leaf form with purple flowers. Except for the probably naturalized populations along roadside between Picota and Bellavista, and on the river bank between Juan Guerra and Shapaja, all *J. gossypifolia* sampled were in towns or in home gardens. In Tarapoto region, the *Jatropha* leaf-miner *Stomphastis thraustica* and the *Jatropha* leaf-rust *Phakospora arthuriana* were widespread, and caused severe leaf loss. When identified, applications seeking permits to import the leaf-miner into a quarantine facility in Brisbane for host-specificity tests will be lodged.

In Bolivia, surveys were conducted across 15 sites in Santa Cruz-Cochabamba region. In addition to the purple leaf *J. gossypifolia* in a home garden, natural/native *Jatropha* populations (*Jatropha excisa* and *Jatropha clavuligera*) with deeply-lobed green leaves were seen along roadsides and in dry arid forests between Mairana and Comarapa in Santa Cruz Department and between La Villa and Arani in Cochabamba Department. There appears to be distinct variations in the morphological traits (e.g. flower colour, fruit colour, depth of lobbing in leaves, number of leaf lobes, width of leaf-lobes, etc) between various *Jatropha* populations in Bolivia. In both the purple (*J. gossypifolia*) and green-leaf (*J. excisa* and *J. clavuligera*) forms, severe damage by the *Jatropha* leaf-miner *Stomphastis thraustica* and the *Jatropha* leaf-rust *Phakospora arthuriana* were seen. The leaf-miner was not seen on *Jatropha curcas* and the castor oil (*Ricinus communis*) plants that co-occurred with *J. gossypifolia*. The green-leaf *J. clavuligera* in dry forests showed evidence of widespread shoot-tip dieback due to galling of shoot-tips, emerging leaves and stems. Only three fresh leaf-galls were collected, as most of the *J. clavuligera* plants had started dropping leaves due to the onset of dry season. From the three fresh galls, several immature cecidomyiid larvae were recovered. A survey during the wet season (January-February 2014) is needed to collect fresh galls to identify the cecidomyiid. A fruit-feeding scutellerid (*Chelycoris lethierryi*) was also collected on *J. clavuligera*.

In Paraguay, surveys were conducted across 16 sites. All *J. gossypifolia* plants sampled were in towns and home gardens and were the purple-leaf form. It is likely that *J. gossypifolia* in Paraguay is an introduced population, and not a native. In most sites, *J. gossypifolia* showed evidence of old shoot-tip dieback, caused by the cecidomyiid *Prodiplosis* sp. near *longifila* (a species that was previously collected on *J. gossypifolia* from Paraguay in 2012). Leaf-feeding lepidopteron larvae (family Notodontidae) were consistently collected on *J. gossypifolia* from most of the survey sites. The larvae were not found on closely related castor oil (*R. communis*) plants. The larvae were sent to a quarantine facility in South Africa, for rearing and identification. No leaf-rust was seen in Paraguay.

Samples of the leaf-rust collected from Peru and Bolivia (including purple-leaved plants) were exported to CABI (UK) and DAFF (Queensland) for identification. The insects collected were sent to relevant taxonomy experts for identification.

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## 1. Background

Bellyache bush, *Jatropha gossypifolia*, a Weed of National Significance (WoNS), is a serious and expanding weed of northern Australia (Bebawi *et al.*, 2007). It invades grazing land, particularly riparian zones, forming dense thickets that reduce pasture and cattle productivity. All parts of the plant, especially the seeds, are toxic and there have been several instances where the death of grazing animals has been attributed to bellyache bush. Bellyache is a declared target for biological control (Heard *et al.*, 2012). Having an effective biological control agent is considered necessary to halt the spread and reduce the impact of bellyache bush in northern Australia.

*Jatropha gossypifolia* is a deciduous shrub native to tropical America, occurring in Florida and Mexico in North America; Guatemala, Nicaragua, Costa Rica, Honduras, Panama, and El Salvador in Central America; Dominican Republic, Puerto Rico, Netherlands Antilles, Trinidad, and Leeward Islands in the Caribbean; and Colombia, Venezuela, Guyana, French Guiana, Ecuador, Bolivia, Peru, Paraguay, Brazil and Argentina in South America (Prentis *et al.*, 2009). In South America, it occurs predominantly in drier areas around the Amazon basin as far south as Argentina.

Biological control efforts for bellyache bush were initiated in 1999 by CSIRO Entomology in partnership with the Governments of Queensland and Northern Territory, termed Phase I. Phase I of the bellyache bush program continued till 2004. Native range surveys were conducted in Mexico, Guatemala, Nicaragua, Costa Rica, Dominican Republic, Puerto Rico, Netherlands Antilles, Trinidad, Cuba, Venezuela, and Ecuador which resulted in the release of the jewel bug, *Agonosoma trilineatum* in Queensland and the Northern Territory (Heard *et al.*, 2009). Despite the release of large numbers of this insect, there is still no evidence of its establishment (Heard *et al.*, 2012).

Phase II of the bellyache bush biocontrol research program was initiated in 2007 with funding from the Queensland Governments' Blueprint for the Bush program and continued until June 2011. As part of this program, further native range surveys were made by CSIRO in Tropical America (partly funded by MLA via B.NBP.0366), but only a few promising agents were identified with the best candidate being the *Jatropha* rust *Phakopsora arthuriana* Buriticá & J F Hennen (synonym *Phakopsora jatrophiicola* Cummins) (Heard *et al.*, 2012). CABI (UK) was commissioned by Biosecurity Queensland (partly funded by MLA via B.NBP.0661) to conduct host-specificity tests for the *Jatropha* rust *P. arthuriana* (Seier *et al.* 2009; Seier and Ghislaine 2010; Pollard 2011; Pollard and Seier 2013). The host specificity test for the *Jatropha* rust is in the final stages of completion, and is expected to be completed by May 2014.

At present, this rust is the only promising agent available (Taylor *et al.*, 2009). Simulated herbivory studies have indicated that a combination of agents attacking different plant parts is needed to overcome compensation by bellyache bush (Pyle 2008) and so provide effective control. There have been increasing community requests for continuation of the biological control program on *J. gossypifolia*, as the weed is now spreading to isolated regions of Cape York, the Gulf of Carpentaria, Lake Eyre Basin, the Northern Territory and the Kimberley region of Western Australia.

So far most of the survey efforts for potential biological control agents for bellyache bush have focused on the Caribbean Islands, Mexico and northern South America and only limited surveys have been made in southern South America, including

Brazil, Peru, Bolivia and Paraguay. In a recent survey in southern South America (March-April 2012), no *J. gossypiifolia* was encountered in northern Argentina or southern Brazil. However, in southern Paraguay, an unidentified cecidomyiid causing shoot-tip die back was collected from *J. gossypiifolia*. Based on this encouraging result from southern Paraguay, survey efforts were initiated for biological control agents for *J. gossypiifolia* in northern Paraguay, Bolivia and Peru.

## 2. Project objectives

1. Conduct surveys in Paraguay, Peru and Bolivia in locations based on herbaria records for potential biological control agents for *J. gossypiifolia* collected (achieved - surveys were conducted at 42 sites in Peru, 15 sites in Bolivia and 16 sites in Paraguay and 12 insects, one mite and one rust fungus were catalogued).
2. Export to a quarantine facility in South Africa (PPRI, Pretoria) potential agents collected in South America for rearing and identification (achieved – shoot-tip/leaf galling cecidomyiid from Bolivia, leaf-mining gracillariid moth from Peru and Bolivia, and leaf-feeding cecidomyiid from Paraguay were exported to a quarantine facility in South Africa, where they were reared through to adults and sent to relevant taxonomic experts for identification).
3. Obtain import permits and export *Jatropha* cecidomyiid (causing *Jatropha* shoot-tip dieback) via South Africa from southern Paraguay into the quarantine facility at the Ecosciences Precinct (Brisbane), if the cecidomyiid is identified to species level and there has been no evidence of this species on any other host plants (not achieved – the shoot-tip dieback causing cecidomyiid from Paraguay, identified as *Prodiplosis* sp. near *longifila*, was not imported in to the quarantine in Australia for further testing, as *P. longifila* is a well known polyphagous pest species).
4. Identify to species level and prioritise agents collected on *J. gossypiifolia* for detailed host specificity tests in Australia, based on host plant records and field damage (achieved – Ten out of 14 agents collected were identified to species level. Based on the restricted field host range in South America, the *Jatropha* leaf-miner *S. thraustica* has been prioritised for detailed host specificity testing).

## 3. Methodology

Various herbaria records suggest that *J. gossypiifolia* occurs in South America (Missouri Botanic Gardens - 11 records in Bolivia, 10 records in Paraguay, and 10 records in Paraguay). The following collaborators have been identified in South Africa, Peru, Bolivia and Paraguay:

1. Dr Stefan Naser  
Plant Protection Research Institute,  
Pretoria, South Africa

2. Dra. Diana Silva Dávila  
Departamento de Entomología  
Museo de Historia Natural, UNMSM  
Av. Arenales 1256, Apartado 14-0434  
Lima 14, Perú
3. Damian I. Rumiz  
*Museo de Historia Natural Noel Kempff Mercado,*  
Universidad Autónoma Gabriel René Moreno,  
Santa Cruz de la Sierra, Bolivia
4. Carlos Aguilar Julio  
Asesor Científico de la Sección Invertebrados  
Museo Nacional de Historia Natural de Paraguay  
Km 10,5 Ruta Mariscal Estigarribia  
Sucursal de Correos N° 1, Central XI, Campus Universitario.  
CP: 16.000- San Lorenzo- Paraguay

Permit to conduct surveys in Peru (Annexure 1) was obtained through the collaborator in Peru. Travel itinerary details were finalised in consultation with the collaborators (Annexure 2), and approval was received from the Minister for the Department of Agriculture, Fisheries and Forestry, Queensland to conduct explorations for biological control agents for bellyache bush in Peru, Bolivia and Paraguay.

Surveys were conducted over a four-week period (31 March to 28 April 2013) on bellyache bush (*J. gossypiiifolia*) and other *Jatropha* species in Paraguay, Peru and Bolivia, at locations identified from herbaria records. During the surveys, closely-related euphorbiaceous plants (e.g. *Ricinus communis*, *Manihot esculentum*) were also sampled to check whether any of the insects collected on *J. gossypiiifolia* and other *Jatropha* species occur on the non-target plants as well. Promising insects (immature and adults) were taken alive to a quarantine facility in Pretoria, South Africa by Dr Stefan Naser, where the immatures were reared to adults and sent to relevant expert taxonomists for identification. A literature search was conducted on the recorded hosts of all agents identified to species level, and agents with no known host records or recorded only on *J. gossypiiifolia* were prioritised for detailed host-specificity tests in Australia.

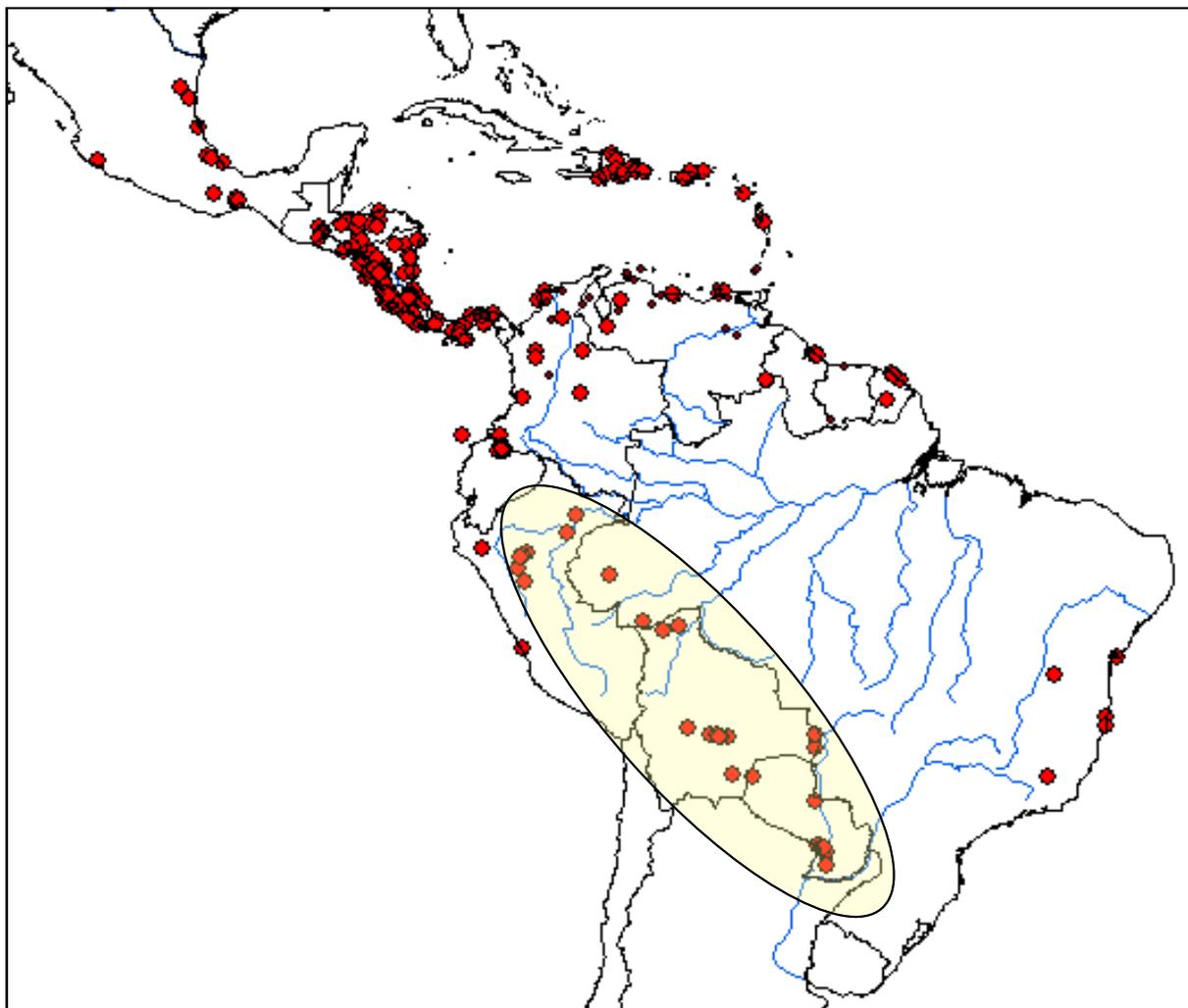


Figure 1. Native range distribution of *Jatropha gossypifolia* based on herbaria records (solid red circles). The region highlighted in yellow refers to the area in Paraguay, Peru and Bolivia where the surveys were conducted.

## 4. Results

### 4.1. Survey in Peru

Surveys were conducted across 42 sites in Tarapoto and Iquitos regions in northern Peru, in partnership with Dr Stefan Naser from the Plant Protection Research Institute of South Africa, and Diana Silva Davila, Luis Ernesto Gonzales and Pavel Sanchez from the Departamento de Entomologia, Museo de Historia Natural, UNMSM in Lima.

#### 31/3/2013 (Sunday)

5.30 am: Departure from home (Taringa, Brisbane).

6.00 pm Arrival at Lima (Peru) – via Auckland (New Zealand) and Santiago (Chile).

7.00 pm: Checked into the hotel (overnight stay at Lima - Peru)

#### 1/4/2013 (Monday)

9.30 am- 12.30 pm: Visited the Departamento de Entomologia, Museo de Historia Natural, UNMSM in Lima (Peru). Dra Diana Silva Davila (Diana), our local

collaborator in Peru, helped us to arrange permits to conduct surveys in Peru, vehicles for transportation, and arranged the Museum staff to accompany us during the surveys in Peru. Unable to meet Diana in the museum, due to her prior lecturing commitments at the University. Met other research staff in the Museum, including Luis Ernesto Razuri Gonzales (Ernesto), who accompanied us during the surveys in Tarapoto.

1.00 pm: Met Stefan Naser (Stefan) from the Plant Protection Research Institute of South Africa at the hotel. Stefan accompanied me over the next four week to conduct surveys for bellyache bush (*Jatropha gossypifolia*).

5.00 - 9.00 pm: Met Ernesto at the Lima airport. Travelled from Lima to Tarapoto (by air).

9.30 pm: Checked into the hotel (overnight stay at Tarapoto - Peru)

### **2/4/2013 (Tuesday)**

Met Victor Hugo Sanchez (Victor) at the hotel. Victor previously worked at Instituto Nacional de Investigacion Agraria (INIA) in Tarapoto on insect pests of *J. curcas*. He was able to provide provisional names for some of the insects encountered (as known from *J. curcas*). Discussed travel routes with Ernesto, Victor and Stefan. Travelled from Tarapoto to Moyabamba (towards east) and returned back to Tarapoto. Victor and Ernesto accompanied us during the surveys in the Tarapoto region from 2 to 7 April.

8.30 am: Departed from Tarapoto.

9.30 am: Sampled two roadside *J. gossypifolia* (with purple leaf & green fruits) and a *Jatropha curcas* plant in the outskirts of Tarapoto (S 06°29'03.3"; W 76°22'13.0"). On *J. gossypifolia* there was evidence of old leaf-miner damage. Black tubuliferan thrips, green cicadellid (*Empoasca* sp.) and a pentatomid bug were collected. On *J. curcas*, a black tubuliferan thrips, a green cicadellid (*Empoasca* sp.) and mealybug (*Planococcus* sp.) were collected.

11.30 am: Sampled roadside *J. gossypifolia* (one large plant with purple leaf & green fruits and three small plants) in front of a house in Ramirez town (S 06°10'10.5"; W 76°50'00.3"). No insects or rust fungi were seen.

3.00 pm: Sampled several *J. gossypifolia* plants (with purple leaf & green fruits) and one *J. curcas* plant in a home garden in the outskirts of Moyabamba town (S 06°03'08.0"; W 76°56'24.7"). On *J. gossypifolia* green cicadellid (*Empoasca* sp.), mealybug, whiteflies, and a pentatomid bug, all generalists, were collected.

4.00 pm: Sampled one isolated roadside *J. gossypifolia* (with purple leaf & pink flowers) in La Huaripa (S 06°13'24.0"; W 76°49'08.9"). No insect damage or leaf rust was seen.

6.00 pm: Sampled several *J. gossypifolia* plants (about 8 plants, all with purple leaf) in home gardens in Lamas town (S 06°25'31.2"; W 76°31'05.9"). The green cicadellid (*Empoasca* sp.), a large black jassid, and a coleopteran larva were collected. No specialist insect or rust fungus was seen.

7.00 pm: Returned back to Tarapoto (overnight stay at Tarapoto - Peru)

### **3/4/2013 (Wednesday)**

Travelled from Tarapoto to Pizana (towards south) and returned back to Tarapoto.

5.30 am: Departed from Tarapoto.

11.30 am: Sampled an isolated *J. gossypiifolia* (with purple leaf & purple flowers) along roadside in Pizana town (S 08°00'27.3"; W 76°38'48.8"). All mature and older leaves on the plant were severely infected with a rust fungi resulting in premature leaf-drop. One black tubuliferan thrips was collected.

12.30 pm: Sampled *J. gossypiifolia* (about 15 plants all with purple leaves & purple flowers) in a home garden near the Pizana town (S 08°00'07.1"; W 76°38'56.6"). Black tubuliferan thrips, green cicadellid (*Empoasca* sp.), large cicadellids (*Molomea consolidata*), and a cercopid bug were collected. No leaf rust was observed.

4.15 pm: Sampled one *J. gossypiifolia* (with purple leaves & purple flowers) along roadside (S 07°24'14.0"; W 76°40'06.2"). Black tubuliferan thrips, green cicadellid (*Empoasca* sp.), and severe leaf spot disease (leaf-necrosis) were recorded. No leaf rust was evident.

5.00 pm: Sampled two mature and two young *J. gossypiifolia* plants (all with purple leaves & purple flowers) along roadside (S 07°24'14.0"; W 76°40'06.2"). All plants were severely infected with leaf rust. Polyphagous green cicadellid (*Empoasca* sp.), mealybug and corn rootworm beetle (*Diabrotica* sp.) were seen feeding on the plant.

6.00 pm: Sampled three *J. gossypiifolia* plants (all with purple leaves & purple flowers) and a *J. curcas* plant, along roadside in front of a house near Juanjui town (S 07°09'39.9"; W 76°43'57.5"). All *J. gossypiifolia* plants were severely infected with leaf rust. Majority of the leaves were also showed leaf-miner damage with either live larvae or pupae. Leaf samples were collected for leaf-miner identification. On *J. curcas*, no leaf rust was evident, and only two leaf-mines were seen as against multiple leaf-mines in almost all leaves of all *J. gossypiifolia* plants.

8.30 pm: Returned back to Tarapoto (overnight stay at Tarapoto - Peru).

### **4/4/2013 (Thursday)**

Travelled from Tarapoto to Yurimaguas (towards north) and returned back to Tarapoto.

9.30 am: Departed from Tarapoto.

11.30 am: Sampled two roadside *J. gossypiifolia* plants (with purple leaves) towards Pampa Hermosa (S 06°06'34.2"; W 76°16'17.6"). Leaf rust, black tubuliferan thrips and green cicadellid (*Empoasca* sp.) were collected. There was no evidence of leaf-miner damage.

12.30 pm: Sampled roadside *J. gossypiifolia* plants (with purple leaves) in Pampa Hermosa (S 05° 54'19.9"; W 78°06'38.6"). Leaf rust, black tubuliferan thrips and green cicadellid (*Empoasca* sp.) were collected.

2.45 pm: Sampled an isolated *J. gossypiifolia* plant (with purple leaves) along roadside in Pampa Hermosa region (S 05°54'22.8"; W 78°16'17.6"). Leaf rust, black tubuliferan thrips and green cicadellid (*Empoasca* sp.) were collected.

3.45 pm: Sampled roadside *J. gossypiifolia* plants (with purple leaves) in Pampa Mermosa (S 06°06'26.2"; W 76°16'08.9"). Leaf rust, leaf spot disease, black tubuliferan thrips and green cicadellid (*Empoasca* sp.) were seen on the plants. Thrips and leaf rust samples were collected for identification.

5.45 pm: Sampled roadside *J. gossypiifolia* plants (with purple leaves and purple flowers) in the outskirts of Tarapoto town (S 06°29'47.0"; W 76°21'21.0"). Leaf-miner and leaf rust damages were widespread occurring in almost in all the leaves. Black tubuliferan thrips, green cicadellid (*Empoasca* sp.) and whiteflies were also seen.

6.30 pm: Returned back to Tarapoto (overnight stay at Tarapoto - Peru)

#### **5/4/2013 (Friday)**

Travelled from Tarapoto to Bellavista (towards south) and returned back to Tarapoto.

9.00 am: Departed from Tarapoto.

9.45 am: Sampled a large population of *J. gossypiifolia* plants (with purple leaves) in a private garden in Tres de Octubre (S 06°32'50.1"; W 76°20'43.2"). Leaf rust, leaf-miner, a probably polyphagous spider mite (*Tetranychus* sp.?) and green cicadellid (*Empoasca* sp.) were collected.

11.15 am: Visited the INIA experimental farm in El Porvenir (S 06°35'35.4"; W 76°19'27.2"). A large trial site for *J. curcas* agronomic experiment was surveyed. In addition, couple of *J. gossypiifolia* plants (with purple leaves and purple flowers) that occurred in the INIA campus were also surveyed. On *J. gossypiifolia*, leaf rust and green cicadellid (*Empoasca* sp.) were found. In contrast, on *J. curcas*, only the green cicadellid (*Empoasca* sp.) was seen, with no evidence of the leaf rust.

11.30: Visited the INIA research station and met Patricia del Carmen Orihuela Pasquel (Patricia) and her research team working the management of insect pests of *J. curcas*. Saw the insect collections from *J. curcas*.

12.00 pm: Sampled a large population of *J. gossypiifolia* plants (with purple leaves) grown as living fence in a private property (S 06° 35'57.9"; W 76°18'23.4"). The plants looked very stressed and unhealthy and there was no evidence of any insect damage or disease incidence.

12.30 pm: Sampled a large population of *J. gossypiifolia* plants (with purple leaves) in a forest area along road side near the town of Buenos Aires (S 06°47'32.2"; W 76°19'22.6"). All plants had leaf-miner damage and leaf rust incidence in almost all leaves. Leaf-miner pupae and leaf rust samples were collected for identification.

1.00 pm: Sampled a large population of probably naturalised *J. gossypiifolia* plants (with purple leaves) along roadside 2-3km from the town of Buenos Aires (S 06°48'09.2"; W 76°20'05.4"). All plants had leaf-miner damage and leaf rust incidence in almost all leaves. Leaf-miner pupae and leaf rust samples were collected for identification. A large cicadellid (*M. consolidata*) feeding on leaves was also collected.

2.45 pm: Sampled several purple leaved *J. gossypiifolia* plants (with purple leaves) along roadside near the town of Picota (S 06° 55'19.8"; W 76°21'54.4"). All plants had leaf-miner damage and leaf rust incidence. The green cicadellid (*Empoasca* sp.) was also seen on most plants. Leaf-miner pupae and leaf rust samples were collected for identification.

3.15 pm: Sampled roadside *J. gossypiifolia* plants (all with purple leaves) near the town of Caspizapa (S 06° 57'28.9"; W 76°25'18.6"). All plants had leaf-miner damage and leaf rust incidence. Leaf-miner pupae and leaf rust samples were collected for identification.

3.30 pm: Sampled roadside *J. gossypiifolia* plants (> 20 plants; all with purple leaves) near the town of Bellavista (S 07° 02'39.2"; W 76°30'58.8"). All plants had leaf-miner damage and leaf rust incidence. The leaf-miner incidence at this site very severe, with up to 11 leaf mines seen on individual leaves, and as many as seven pupae of the Leaf-miner collected on individual leaves. No leaf-miner damage was seen on a nearby isolated *J. curcas* plant and castor oil (*R. communis*) plants grown widely in that area. The leaf-rust was also not seen on *J. curcas*.

4.00 pm: Sampled a large population of roadside *J. gossypiifolia* plants (all with purple leaves) in the town of Bellavista. All plants had leaf-miner damage and leaf rust incidence. Incidence of green cicadeliad (*Empoasca* sp.) and a mealybug (*Pseudococcus* sp.?) was also recorded.

8.30 pm: Returned back to Tarapoto (overnight stay at Tarapoto - Peru)

#### **6/4/2013 (Saturday)**

Travelled from Tarapoto to Chazuta (towards east) and returned back to Tarapoto.

9.30 am: Departed from Tarapoto.

10.15 am: Sampled a large probably naturalized population of *J. gossypiifolia* plants (with purple leaves) along riverside (S 06°35'00.8"; W 76°17'39.5"). Leaf-rust incidence was widespread, but only one leaf-miner pupa was collected. Other insects seen on *J. gossypiifolia* include whiteflies and a large cicadellid. Balloon vine rust and lantana leaf gall mite were also seen at this site.

11.00 am: Sampled several *J. gossypiifolia* plants (with purple leaves) along roadside (S 06° 34'41.1"; W 76°17'32.7"). Leaf-rust incidence and leaf-miner damage were seen along with the incidence of a large (colourful) cicadellids (*Erythrogonia* sp.).

11.30 am: Sampled several *J. gossypiifolia* plants (mature plants and seedlings, all with purple leaves) in a home garden in Shapaja town (S 06°34'48.4"; W 76°15'39.4"). A large *J. curcas* plant was also sampled at this site. Leaf-rust was evident on all *J. gossypiifolia* plants. All *J. gossypiifolia* plants also showed signs of leaf-miner damage, but no live larvae or pupae could be collected. A large (colourful) cicadellid (*Erythrogonia* sp.) was collected. On *J. curcas*, one leaf-miner pupae was collected. But there was no evidence of leaf-rust incidence on *J. curcas*.

12.30 pm: Sampled isolated *J. gossypiifolia* plants (with purple leaves) in a home garden in the town of Chazuta (S 06°34'27.6"; W 76°08'13.0"). Leaf-rust was seen on all leaves, but there was no evidence of the leaf-miner damage. On many leaves large congregations of very small mites along the leaf-veins and at the base of the leaves were seen. But there was no evidence of any feeding damage by the mites. It is suspected that the mites are possibly fungal feeders. Mite samples were collected for identification. Mealybugs, black tubuliferan thrips and green cicadellid were also collected at this site.

2.30 pm: Sampled isolated *J. gossypiifolia* plants (with purple leaves) and *J. curcas* plants grown in a home garden and castor oil plants grown wild along roadside, in the

outskirts of Tarapoto town. Leaf-miner incidence was seen only on *J. gossypiifolia*, and there was no evidence of leaf-miner damage on both *J. curcas* and castor oil plants.

2.45 pm: Sampled seven *J. gossypiifolia* (with purple leaves) and *J. curcas* plants grown in a home garden and castor oil plants grown wild along roadside, in the outskirts of Tarapoto town (few hundred meters from the previous two sites). Leaf-miner incidence was seen only on *J. gossypiifolia* plants, and there was no evidence of leaf-miner damage on both *J. curcas* and castor oil plants.

4.15 pm: Sampled two *J. gossypiifolia* plants (with purple leaves), two *J. curcas* plants and two castor oil plants in the Tarapoto town (Barrio Partido Alta). There was evidence of leaf-miner damage only on *J. gossypiifolia* and not on the two other species.

5.30 pm: Returned back to Tarapoto (overnight stay at Tarapoto - Peru).

#### **7/4/2013 (Sunday)**

The entire day was spent processing the plant, insect and rust samples collected over the week. The plant samples were processed for herbarium records, the rust-infected leaves were processed for export to CABI (UK) and DAFF-Qld for identification and culturing; and the insect samples were processed (pinning and labelling) for identification.

Overnight stay at Tarapoto – Peru.

#### **8/4/2013 (Monday)**

Travelled from Tarapoto to Iquitos – by air via Lima.

10.30 am: Visited the local post-office and mailed *Jatropha* leaf rust samples to CABI (UK).

11.30 am: Departure from Tarapoto.

6.00 pm: Arrival at Iquitos (via Lima). Met Pavel Sivrac Sanchez Flores from the Museo de Historia Natural in Lima at the Iquitos airport. Pavel accompanied us during the surveys in Iquitos region from 9 to 12 April.

Overnight stay in Iquitos – Peru.

#### **9/4/2013 (Tuesday)**

Conducted surveys in and around Iquitos town (by walking and by MotoTaxi).

10.00 am: Conducted surveys in settlements along Rio Amazonia (S 03°45'10.2"; W 73°14'38.8"). Isolated purple leaved *J. gossypiifolia* plants and seedling near a house were sampled. Almost all leaves showed severe rust infestations. Several dipteran larvae were found on the rust infected leaves – possibly fungal feeding larvae. Samples of rust-infected leaves and dipteran larvae were collected. There was no evidence of leaf-miner damage.

11.00 am: Sampled one *J. gossypiifolia* plant in front of a house in San Lorenzo street in San Juan district (S 03°45'54.9"; W 73°16'21.5"). All leaves showed severe rust infestations. Many leaves also had the fungal feeding dipteran larvae. The green cicadellid and a large cicadellid were also collected. There was no leaf-miner damage.

12.00 pm: Visited the Instituto de Medicina Tradicional (IMET) and met Jorge Villacres Vallejo (Jorge), an agronomist who works at the Universidad Nacional de la Amazonia Peruana (UNAP). Jorge provided as lots of literature on *J. gossypiifolia* in Peru and also offered to show us his *J. gossypiifolia* plants he maintains in his agronomic trial sites at the university campus at Zungarococha near Iquitos. As per the book 'Plantas Medicinales del Peru', *J. gossypiifolia* is indicated as a native of Peru. One *J. gossypiifolia* plant maintained at the medicinal plant collection at the IMET campus was sampled. Leaf-rust incidence was evident in almost all leaves, but there was no leaf-miner damage.

1.00 pm: Visited the Instituto de Investigaciones de la Amazonia – Peru (IIAP) and met Kember Mejia, a scientist specialising on forestry plants. Kember was not familiar with *J. gossypiifolia* plants and there was no evidence of any work being done at IIAP on *J. gossypiifolia*.

2.00 pm: Visited the Botanic garden in Quistococha (S 03°30.5"; W 73°19'15.6"). Several *J. gossypiifolia* plants (all with purple leaves) were grown in the medicinal plant garden. Leaf-rust was widespread in all *J. gossypiifolia* plants. Soft-scale insects (most likely polyphagous) were also collected from the plants.

4.30 pm: Sampled four *J. gossypiifolia* plants (all with purple leaves) along roadside in Zungarococha (S 03°49'20.0"; W 73°19'31.9"). All leaves showed rust infestations. No leaf-miner damage.

5.00 pm: Sampled four *J. gossypiifolia* plants (all with purple leaves) along roadside in San Juan, near the new University building (S 03°46'22.0"; W 73°17'01.5"). All leaves showed rust infection. Severe mealybug infestation was also evident in some branches. No leaf-miner damage.

5.30 pm: Returned back to Iquitos (overnight stay at Iquitos).

### **10/4/2013 (Wednesday)**

Travelled from Iquitos to Nauta by MotoTaxi and conducted surveys along roadside.

9.00 am: departure from Iquitos.

10.00 am: Sampled three roadside *J. gossypiifolia* plants in San Juan (S 03°51'40.4"; W 73°20'13.5"). The plants looked different to the usual purple leaf forms – as all the leaves were dark purple in colour, including the older leaves (unlike the normal purple leaf-form where only young leaves are purple in colour while the older leaves are green in colour). The leaf-rust, though evident, was very low with only two leaves showing the rust infection, with only one or two pustules per leaf. No insect or insect damage was seen.

10.45 am: Sampled an isolated completely purple coloured *J. gossypiifolia* seedling in a home garden in Centro Poblado Cahuide (S 04°13'57.7"; W 73°29'16.4"). No leaf-rust or insect was seen.

11.30 am: Reached Nauta town. There of plenty of normal purple leaf *J. gossypiifolia* plants in wasteland in the town. All plants had leaf-rust, but no insect damage.

4.30 pm: Returned back to Iquitos. Overnight stay in Iquitos.

### **11/4/2013 (Thursday)**

8.30 am: departure from Iquitos (by MotoTaxi).

10.00 am: Visited the Universidad Nacional de la Amazoni Peruana campus at Zungarococha and met Jorge. Surveyed *J. gossypifolia* (> 100 plants, all purple leaved form), *J. curcas* and castor oil (*R. communis*) plants in an agronomic trial site. Leaf-rust was evident in all *J. gossypifolia* plants. Leaf-rust was not seen on *J. curcas* plants. No insect damage on both *J. gossypifolia* and *J. curcas* plants.

3.00 - 5.00 pm: Sample processing in the hotel for export to UK.

Overnight stay in Iquitos.

### **12/4/2013 (Friday)**

9.30-10.30 am: Visit to post office to export rust infected leaf samples to CABI (UK).

12.15 pm: Visited Independencia (by MotoTaxi and boat), a village on Rio Amazonia (S 03° 39'09.8"; W 73°14'04.2"). Purple leaf-form *J. gossypifolia* plants sampled. All plant had leaf-rust. No other insects seen. Walked to the next village (a two hour walk) and conducted road side surveys.

4.00 pm: Returned back to Iquitos.

6.30 pm: Departure from Iquitos.

10.30 pm: Arrival in Lima.

11.50 pm: Departure from Lima.

## **4.2. Survey in Bolivia**

Surveys were conducted across 15 sites in Santa Cruz-Cochabamba region in central Bolivia, in partnership with Dr Stefan Naser from the Plant Protection Research Institute of South Africa, and Damian Rumiz based at the Noel Kempff Mercado Museo de Historia Natural in Santa Cruz.

### **13/4/2013 (Saturday)**

6.00 am: Arrival at Santa Cruz (Bolivia) – La Paz.

2.00 – 4.00 pm: Met Dr Damian Rumiz (Damian), our local collaborator in Bolivia. Damian is an eminent naturalist and forestry scientist based at the Noel Kempff Mercado Museo de Historia Natural in Santa Cruz. Damian provided more *J. gossypifolia* record details in Bolivia and helped to plan survey areas between Santa Cruz and Cochabamba, and organised the vehicle for the travel. Damian also accompanied us during the surveys in Bolivia from 15 to 18 April.

Overnight stay in Santa Cruz (Bolivia).

### **14/4/2013 (Sunday)**

11.00 am – 4.00 pm: Visited the Jardin Botanico Santa Cruz. The native flora in the Jardin represents eastern Bolivian Chaco and subtropical forests over a 186 ha. No *J. gossypifolia* was seen in the Jardin. Lantana, cat's claw creeper and water hyacinth surveyed at the Jardin. On cat's claw creeper, leaf-sucking tingid *Carvalhotingis visenda*, leaf-mining beetle *Hylaeogena jureceki* and cicadellid

*Neocrassana undata* were seen. Feeding damages by the tortoise beetle *Charidotis auroguttata* and the leaf-tying moth *Hypocosmia pyrochroma* were also seen.

Overnight stay in Santa Cruz (Bolivia).

**15/4/2013 (Monday)**

Travelled from Santa Cruz to Comarapa – by car.

8.00 am: Departure from Santa Cruz.

11.30 am: Found a small natural population of *J. gossypiifolia* (with green leaves and yellow/white flowers) along Piray river, below the bridge near Eltorno town (S 18° 06'32.5"; W 3°27'28.3"). No leaf-rust or insect was collected on the plant.

12.15 pm: Sampled four purple leaf *J. gossypiifolia* plants (with purple flowers) in a home garden in Angostura (S 18°09'23.4"; W 63°29'59.5"), a town 60 west of Santa Cruz. Almost all leaves in all plants had leaf-miner damage (about 4-7 leaf-mines per leaf). Leaf-rust was also seen on the plant. Thrips damage (with thrips larvae) seen on few leaves. Sampling of castor oil plant (*R. communis*) nearby area revealed no leaf-miner damage. No leaf-rust or insect was collected on the castor oil plant.

4.00 pm: A natural population of *J. gossypiifolia* plants comprising both young and mature plants (all with hairy green leaves and white flowers) along roadside nature strip in the town of Mairana (S 18°08'26.3"; W 63°56'37.2") was sampled. Evidence of leaf-miner damage was seen in all plants, and in most plants the pupae have all emerged. One leaf-mine was seen on one of the three *J. curcas* plants in the same site. No leaf-mine was seen on castor oil (*R. communis*) plants. The leaf-rust was not seen on both *J. gossypiifolia* and *J. curcas*.

5.30 pm: A large population of *J. gossypiifolia* plants (green leaves with white flower) grown naturally along the roadside in Los Negros town (S 18°02'39.3"; W 64°07'03.4") was sampled. All the plants looked very unhealthy due to severe leaf-rust incidence and leaf-miner damage in almost all leaves. Leaf-miner damage was also seen on a large *J. curcas* tree at the same site, but there was no leaf-miner damage on castor oil (*R. communis*) plants. On *J. curcas*, fruit/seed feeding scutellerid (*Pachycoris torridus*) was collected. But the leaf-rust was not seen on *J. curcas*.

6.00 pm: *Jatropha gossypiifolia* plants (green leaves with white flower) grown naturally along the roadside between Los Negros and Pambagrande (S 18°04'31.9"; W 64°07'12.9.4") was sampled. Incidence of leaf-rust and leaf-miner damage was seen in almost all plants. No other insects were recorded.

8.00 pm: Arrival in Comarapa. Overnight stay in Comarapa.

**16/4/2013 (Tuesday)**

Conducted surveys in and around Comarapa.

8.30 am: departure from Comarapa.

9.30 am: Surveyed a natural population of *J. gossypiifolia* (with hairy, green and deeply lobed leaves) in a dry arid forest along with cacti in Pulquina road, near Comarapa (S 17°58'39.7"; W 64°28'29.6"). Due to the start of the dry season (the season in this part of Bolivia appears about two months ahead of Peru and Paraguay) most plants were shedding their leaves and there was no flowers or fruits

on the plant. Most of the plants showed a few signs of herbivory and insect fauna. There was evidence of shoot-tip dieback, leaf-mining damage, leaf-spot disease, and exuviae of a large cicadellid in most plants, but no insect or leaf-rust was collected. Plant samples were collected for herbarium records. It is likely that survey during early summer (Jan/Feb 2014) may yield more insects and diseases.

10.30 am: Visited Pulkina Areva (S 17°58'14.4"; W 64°26'06.6"). No *J. gossypiifolia* at his site. *Tecoma stans* and Madeira vine were sampled. On *T. stans*, a leaf-miner and a leaf-rust were seen. On Madeira vine, a long-leaf form with no aerial tubers, no insect was seen.

11.30 am: Surveyed a natural population of *J. gossypiifolia* (with hairy, green and deeply lobed leaves) in a dry arid forest near Comarapa (S 17°58'36.0"; W 64°28'27.1"). Most of the plants started dropping leaves due to the onset of dry season, and the remaining leaves were all severely affected by a leaf-spot disease. Many leaves also showed evidence of old leaf-miner damage. No fresh flowers or developing fruits were seen. A survey during early summer (Jan/Feb 2014) may yield more insects and diseases.

12.30 am: Surveyed a natural population of *J. gossypiifolia* (with hairy, green and deeply lobed leaves, brown/purple flower, and green and purple fruits) in a roadside dry arid forest near Comarapa airstrip and Tambo (S 18°00'43.8"; W 64°27'33.9") on Comarapa to San Isidro road (14 km east of Comarapa). Most of the plants started dropping leaves due to the onset of dry season and the remaining leaves showed evidence of old leaf-miner damage and leaf-spot disease. Shoot-tip dieback was seen in almost all braches/shoot-tips, due to shoot-tip/petiole/leaf galling by a cecidomyiid. Only three fresh galls were collected and the cecidomyiid larvae were recovered from the galls for identification. Large spherical stem-galls were also seen, but no insect could be found within the gall. A survey during early summer (Jan/Feb 2014) is needed to collect fresh gall samples to identify the cecidomyiid.

2.00 pm: Surveyed a natural population of *J. gossypiifolia* (with hairy, green and deeply lobed leaves) in a cacti garden (very dry and arid forest full of cacti) in Puliquna Abajo (S 18°05'58.8"; W 64°25'32.1"). The forest was full of *J. gossypiifolia* plants and all of them small and looked severely stressed (due to onset of dry conditions). Most of the plants started dropping leaves and the remaining leaves showed evidence of old leaf-miner damage and leaf-spot disease. Shoot-tip dieback was seen in almost all braches/shoot-tips, possibly due to shoot-tip/petiole/leaf galling by a cecidomyiid. Only one fresh gall was collected. There were no fresh flowers or seeds on the plants, and all inflorescences were aborted. A survey during early summer (January/February 2014) is needed to collect fresh gall samples to identify the cecidomyiid.

5.00 pm: Surveyed *J. gossypiifolia* plants (with hairy, green and deeply lobed leaves) along a creek bed near Comarapa dam (S 17°56'27.0"; W 64°33'41.9"). No evidence of leaf-rust or leaf-miner damage. All plants showed shoot-tip die back, and in many plants, a shoot-tip gall like swelling was prevalent.

7.00 pm: Arrival in Comarapa. Overnight stay in Comarapa.

### **17/4/2013 (Wednesday)**

Travelled from Comarapa to Cochabamba and conducted roadside surveys.

8.30 am: Departure from Comarapa.

4.00 pm: Surveyed a natural population of *J. gossypiifolia* (with hairy, green and deeply lobed leaves, 5-7 lobes, smaller fruit size) on a very steep rocky hill full of cacti, along roadside near La Villa (4 km from Punatha) before Cochabamba (S 17°30'43.6"; W 65°48'40.8"). As in previous sites, most plants were shedding their leaves and there were no fresh flowers or fruits on the plants. Most of the plants showed a few sign of herbivory and insect fauna. There was evidence of insect or leaf-rust damage. Plant samples were collected for herbarium records. It is likely that survey at this site during early summer (January/February 2014) may yield more insects and diseases.

5.30 pm: Surveyed a natural population of *J. gossypiifolia* plant (with hairy, green and deeply lobed leaves, 5-7 lobes, white-purple flowers) on a very dry forest along with cacti near Arani before Cochabamba (S 17°35'01.4"; W 65°45'22.7"). As in previous sites, most plants were shedding their leaves and there were no fresh flowers or fruits on the plants. There was evidence of insect or leaf-rust damage. A seed/fruit feeding scutellerid was collected on *J. gossypiifolia*. Plant samples were collected for herbarium records. It is likely that survey at this site during early summer (Jan/Feb 2014) may yield more insects and diseases.

9.00 pm: Arrival in Cochabamba. Overnight stay in Cochabamba.

#### **18/4/2013 (Thursday)**

Travelled from Cochabamba to Santa Cruz.

8.00 am: Departure from Cochabamba.

9.00 am: Visited El Cristo, a rocky hill in the town. No *J. gossypiifolia* was seen. Balloon vine (*Cardiospermum* sp.) with pink flower was widespread at this site.

10.00 pm: Arrival in Santa Cruz (delay due to roadblocks). Overnight stay in Santa Cruz.

#### **19/4/2013 (Friday)**

9.00 am – 1.00 pm: Visited the Noel Kempff Mercado Museo de Historia Natural in Santa Cruz. Submitted dried *J. gossypiifolia* samples to the herbarium for documentation and identification.

3.00 – 5.00 pm: Processed insect and plant samples.

Overnight stay in Santa Cruz.

#### **20/4/2013 (Saturday)**

12.00 pm: Departure from Santa Cruz.

5.00 pm: Arrival in Asuncion (Paraguay). Met Carlos Aguilar Julio (Carlos) at the airport. Carlos organised the vehicle for the travel and accompanied us during the surveys in Paraguay from 21 to 25 April.

Overnight stay in Asuncion.

### **4.3. Survey in Paraguay**

Surveys were conducted across 16 sites in southern and central Paraguay region, in partnership with Dr Stefan Naser from the Plant Protection Research Institute of South Africa, and Dr Carlos Aguilar Julio, a coleopteran taxonomist based at Asuncion.

**21/4/2013 (Sunday)**

9.30 am: Departure from Asuncion – by car.

11.45 am: Sampled an isolated *J. gossypiifolia* plant (with purple leaves + green fruits) along roadside (2 km from route No.1 to Aregua, towards Ypacari) in Aregua (S 25°20'27.9"; W 57°24'38.7"). A new leaf-feeding lepidopteron larva (family Notodontidae) was collected at this site. One larva was collected in each leaf. The green cicadellid (*Empoasca* sp.) was also seen at this site. But there was no leaf-rust observed.

1.00 pm: Sampled two large *J. gossypiifolia* plants (with purple leaves, purple flowers and green fruits) along roadside (centro de Ypacari al lado de la ruta 2) in Ypacari (S 25°24'05.4"; W 57°17'17.3"). The leaf-feeding lepidopteron larva was collected at this site. One larva was collected in each leaf. Other than the green cicadellid (*Empoasca* sp.) no insect or leaf-rust was seen.

4.00 pm: Sampled an isolated *J. gossypiifolia* plant (with purple leaves) in a home garden (3 km north from Chololo) in Compania Naranjo (S 25°32'16.6"; W 57°03'18.4"). The lepidopteron larvae (the same type of larvae collected in the two previous sites) were collected from almost all leaves in the plant. No other insect or leaf-rust was seen on the plant.

5.00 pm: Sampled castor oil (*R. communis*) plants 1 km from the PA-3 site. There was no evidence of the yellow and black coloured lepidopteron larvae on castor oil plants.

6.30 pm: Arrived in Piribebuy. Overnight stay in Piribebuy.

**22/4/2013 (Monday)**

8.00 am: Departure from Piribebuy.

9.30 am: Sampled *J. gossypiifolia* plants (with purple leaves) along roadside 1 km northeast of Caacupe (S 25°22'20.2"; W 57°08'10.8"). Other than the mealybugs (*Planococcus* sp.) and the green cicadellid (*Empoasca* sp.) no insect or rust-fungi was seen.

10.45 am: Sampled *J. gossypiifolia* plants and seedlings (with purple leaves) along roadside in Tobaty (S 25°18'13.0"; W 57°05'44.1"). Evidence of old shoot-tip dieback was seen in all shoots. The green cicadellid (*Empoasca* sp.) was collected.

1.00 pm: Sampled three *J. gossypiifolia* plants (with purple leaves) along roadside in San Ignacio de Loyola ruta 2, km 97 (S 25°30'38.7"; W 56°46'42.6"). All plants showed evidence of cecidomyiid damage – possibly old (similar to the damage seen in Coronel Bogalo in 2012). Shoot tip samples collected for cecidomyiid larvae.

3.45 pm: Sampled *J. gossypiifolia* plants (two mature and two juvenile plants, all with purple leaves) along roadside in Ytacurubi, Villarrica (S 25°35'28.5"; W 56°16'05.4"). All plants showed severe leaf damage by the lepidopteron larvae and the larvae were collected from almost all leaves (one larva per leaf). Evidence of old cecidomyiid damage to shoot-tips and young leaves was also seen. Shoot tip samples collected for cecidomyiid larvae.

5.00 pm: A population of *J. gossypiifolia* (>50 plants) in a eucalyptus garden (all with purple leaves) was sampled in Sua de Pumi – ruta 8 (S 25°57'23.2"; W 56°19'42.5").

Evidence of old cecidomyiid damage to shoot-tips and young leaves was seen in all plants. Shoot tip samples collected for cecidomyiid larvae. No other insect or leaf-rust was seen.

6.00 pm: Arrived in Caazapá. Overnight stay in Caazapá.

### **23/4/2013 (Tuesday)**

8.30 am: Departure from Caazapá.

9.15 am: Sampled about 20 *J. gossypiifolia* plants (with purple leaves) in a home garden along roadside 5 km east of Boquerón (S 26°15'29.6"; W 56°12'56.6"). Evidence of old cecidomyiid damage to shoot-tips and young leaves was seen in all plants. Green cicadellid (*Empoasca* sp.) and a large ash-coloured cicadellid (*M. consolidata*) were collected. Majority of the leaves showed severe leaf-spot disease symptoms. Leaf-rust was not seen.

3.00 pm: Sampled *J. gossypiifolia* plants (with purple leaves) in a home garden in Coronel Bogado (Barrio San Antonio, Calle Mariscal Estigarribia; 1 km del cementerio) – the same site that was surveyed in 2012 (S 27°08'58.5"; W 56°14'23.6"). Most of the mature plants were either destroyed or removed and only young plants and seedlings were seen. Evidence of old cecidomyiid damage to shoot-tips and young leaves was seen in most plants.

4.00 pm: Sampled about 10 mature *J. gossypiifolia* plants (with purple leaves) in a paddock between San Rafael and San Cosme y Damian (S 27°12'55.9"; W 56°21'29.9"). Evidence of old cecidomyiid damage to shoot-tips and young leaves was seen in most plants. Severe leaf spot disease was seen on older leaves.

5.30 pm: Sampled five mature *J. gossypiifolia* plants (with purple leaves) in a home garden near old Jesuit – the same site that was sampled in San Cosme y Damian (S 27°19'01.1"; W 56°19'57.0") in 2012. Evidence of old cecidomyiid damage to shoot-tips and young leaves was seen in all plants. Several larvae emerged from the shoot-tips, and are likely to pupate and emerge as adults.

Overnight stay in San Cosme y Damian.

### **24/4/2013 (Wednesday)**

9.00 am: Departure from San Cosme y Damian.

1.30 pm: Sampled about 16 *J. gossypiifolia* plants (with purple leaves) in a home garden in Caapuco town (S 26°14'01.7"; W 57°10'29.8"). Evidence of old cecidomyiid damage to shoot-tips and young leaves was seen in all plants. The leaf-spot disease was seen in all plants. No insect or leaf rust was seen, but several cecidomyiid larvae later emerged from collected, damaged shoot tips.

3.15 pm: Saw white-flowered parthenium plants in Paraguairí town. There was no evidence of any insect damage in the parthenium plants.

6.00 pm: Arrived in Piribebuy. Overnight stay in Piribebuy.

### **25/4/2013 (Thursday)**

9.00 am: Departure from Piribebuy.

11.00 am – 1.00 pm: Visited the Asuncion Botanic Gardens. Sampled a *J. gossypifolia* plant and a *J. curcas* plant in the medicinal plant garden. No insect or leaf-rust was seen on both plant species.

2.00 – 5.00 pm: Process plant and insect samples in the hotel room. Plant samples were processed for export to South Africa. Insects were pinned for export to South Africa and Australia.

Overnight stay in Asuncion.

#### **26/4/2013 (Friday)**

12.00 pm: Departure from Asuncion.

3.30 pm: Arrival at Santiago (Chile).

11.50 pm: Departure from Santiago (Chile).

#### **28/4/2012 (Sunday)**

4.00 am: Arrival at Auckland (New Zealand).

6.00 am: Departure from Auckland (New Zealand).

9.00 am: Arrival at Brisbane.

## **5. Conclusion**

Ornamental populations (purple-leaf form) of bellyache bush were seen in Peru, Paraguay and Bolivia. Natural populations (green-leaf form) of bellyache bush were seen only in Bolivia, in the arid regions. A total of 14 agents (12 species of insects, one mite species and one rust fungus) were collected from South America (Table 1). Among them, a leaf-mining gracillariid moth from Bolivia and Peru (Figure 2.A), a shoot-tip/leaf galling cecidomyiid from Bolivia (Figure 2.B), and a leaf-feeding cecidomyiid and an unidentified notodontid larvae from Paraguay were exported to a quarantine facility in Pretoria, South Africa where they were reared through to adults and sent to relevant taxonomic experts for identification. Identifications of the leaf-mining gracillariid moth *Stomphastis thraustica* from Bolivia and Peru (Figure 2.A) and the leaf-feeding cecidomyiid *Prodiplosis* sp. near *longifila* from Paraguay have been confirmed, while the identification of the shoot-tip/leaf galling cecidomyiid (Figure 2,B) from Bolivia is in progress. None of the notodontid larvae from Paraguay developed into adults in the quarantine facility in South Africa and hence could not be identified. Other insects collected from South America were polyphagous or pest species. The leaf-rust *P. arthuriana* was also collected from both Bolivia and Peru (Table 1). The promising insect species collected on bellyache bush from South America appear unique and different from the species collected from Mexico, Central America and the Caribbean. The limited number of insect species collected from bellyache bush in the arid regions in Bolivia was due to the surveys conducted late in the dry season. Hence, further exploration needs to be conducted in Bolivia in the wet season to study the field host range and damage levels of the previously collected agents and to look for new agents. Based on the restricted field host range in South America, an application to import the *Jatropha* leaf-miner (*S. thraustica*) in to the quarantine in Brisbane, Australia for host-specificity testing has been submitted to relevant regulatory authorities in Australia. An application seeking permits to import

the shoot-tip galling cecidomyiid from Bolivia will be submitted, when identified to species level, and if there are no recorded hosts other than *Jatropha* spp.

**Table 1. Insects, mite and rust fungi associated with *Jatropha* species in South America.**

Species	Order/Family	Feeding habit	Countries	Host range/spectrum
<i>Stomphastis thraustica</i>	Lepidoptera: Gracillariidae	Leaf miner	Peru and Bolivia	<i>Jatropha</i> spp.
<i>Chelycoris lethierryi</i>	Hemiptera: Pentatomidae	Seed/fruit feeder	Bolivia	Generalist
<i>Gynaikothrips uzeli</i>	Thysanoptera: Phlaeothripidae	Leaf	Peru	Accidental?
<i>Prodiplosis</i> sp. near <i>longifila</i>	Diptera: Cecidomyiidae	shoot tip	Paraguay	Unknown
<i>Prodiplosis</i> sp.	Diptera: Cecidomyiidae	Shoot tip galls	Bolivia	<i>Jatropha</i> spp.
<i>Empoasca</i> sp.	Hemiptera: Cicadellidae	Leaf and stem	Peru, Paraguay	Polyphagous
<i>Planococcus</i> sp.	Hemiptera: Pseudococcidae	Leaf and stem	Peru, Paraguay	Polyphagous
<i>Diabrotica virgifera</i>	Coleoptera: Chrysomelidae	Leaf-feeder	Peru	Polyphagous
<i>Molomea consolidata</i>	Hemiptera: Cicadellidae	Leaf	Peru, Paraguay	Polyphagous
<i>Erythrogonia areolata</i>	Hemiptera: Cicadellidae	Leaf	Peru	Polyphagous
<i>Pachycoris torridus</i>	Hemiptera: Scutelleridae	Leaf, fruit and flower	Bolivia and Paraguay	Polyphagous
Unidentified larva	Lepidoptera: Notodontidae	Leaf	Paraguay	Unknown
<i>Ricoseius ?loxocheles</i>	Acarina: Phytoceiidae	Leaf?	Peru	Unknown
<i>Phakopsora arthuriana</i>	Uredinales: Phakopsoraceae)	Leaf rust	Peru and Bolivia	<i>J. gossypifolia</i> & <i>J. curcas</i>



**Figure 2. Damage by the leaf-miner (A) Peru and the gall-midge (B) in Bolivia.**

## 6. Acknowledgments

This project was funded by the Meat and Livestock Australia. Surveys were conducted in collaboration with Dr Stefan Naser (Plant Protection Research Institute, Pretoria, South Africa). Dra. Diana Silva Davila, Luis Ernesto Gonzales and Pavel Sanchez from the Departamento de Entomologia, Museo de Historia Natural, UNMSM in Lima; Dr Damian Rumiz from the Noel Kempff Mercado Museo de Historia Natural in Santa Cruz, Bolivia; and Dr Carlos Aguilar Julio from Asuncion, Paraguay provided valuable help during the survey in South America. V.M. Uys (USDA), D.R. Davis (Smithsonian Institute), M. Kruger (Ditsong Museum), L. Mound (CSIRO), R. Gagne (USDA), R.G. Shivas (Queensland Mycology Herbarium), O. Seeman (Queensland Museum), V.H. Sanchez (Instituto Nacional de Investigacion Agraria, Peru) and M.K. Seier (CABI-UK) helped to identify various insects, mites and rust fungi collected during the survey.

## 7. Appendices

### 7.1 Appendix 1. Permit to conduct surveys in Peru

See attached document.

### 7.2 Appendix 2. South America travel itinerary

See attached document.

## 8. Bibliography

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## **Appendix 1. Permit to conduct surveys in Peru**



PERÚ

Ministerio de Agricultura

Dirección General  
Forestal y de Fauna  
Silvestre

Dirección de Gestión  
Forestal y de Fauna  
Silvestre

"Decenio de las Personas con Discapacidad en el Perú"  
"Año de la Inversión para el Desarrollo Rural y la Seguridad Alimentaria"

Lima, 14 MAYO 2013

**CARTA N° 666-2013-AG-DGFFS-DGEFFS**

Señor

**Kunjithapatham Dhileepan**

Departamento de Agricultura, Pesca y Silvicultura  
Escosciences Precinct, 41 Boggo Road Dutton Park  
Brisbane, Queensland 4102-Australia  
k.dhileepan@daff.gld.gov.au  
dianasil@gmail.com

Asunto : Remito Resolución Directoral N° 115-2013-AG-DGFFS-DGEFFS

Tengo el agrado de dirigirme a usted, para remitirle adjunto copia fedateada de la **Resolución Directoral N° 115-2013-AG-DGFFS-DGEFFS**, para su conocimiento y fines, mediante el cual se resuelve autorizar la investigación científica en flora y fauna silvestre, la colecta de insectos y ácaros asociados a la especie *Jatropha gossypifolia*; fuera de Áreas Naturales Protegidas en los departamentos de San Martín e Iquitos; como parte del proyecto "Exploración e Identificación de Insectos Asociados con la Planta *Jatropha gossypifolia* en el Perú" por el periodo de un año, contado a partir de la emisión de la mencionada Resolución.

Atentamente,



**Abog. Silvia Velásquez Silva**  
Directora de Gestión Forestal y de  
Fauna Silvestre (e)

Adj. 02 Folios  
CUT: 14760-2013



# CERTIFICO

Que la presente Fotocopia es auténtica y Exactamente igual al documento original que he tenido a la vista y con el cual ha sido Confrontada.



Lima, 9 MAYO 2013

MARIA DEL PILAR TUPPIA VILLACORTA  
FEDIATARIA SUPLENTE  
R. M. N° 0222-2011-AG

## RESOLUCIÓN DIRECTORAL N° 115 -2013-AG-DGFFS-DGEFFS

Lima, 08 MAYO 2013

### VISTA:

La solicitud de autorización para realizar actividades de investigación científica y filmaciones con fines comerciales de flora y fauna silvestre, fuera de Áreas Naturales Protegidas, con código único de trámite N° 14760, de fecha 01 de febrero de 2013, presentado por el señor Kunjithapatham Dhileepan, identificado con Pasaporte N° N4708146; y,

### CONSIDERANDO:

Que, mediante solicitud de fecha 01 de febrero de 2013, el señor Kunjithapatham Dhileepan, solicita autorización para realizar actividades de investigación científica fuera de Áreas Naturales Protegidas, con colecta de fauna silvestre; proponiendo evaluar en los departamentos de Cajamarca, San Martín e Iquitos; como parte del proyecto "Exploración e Identificación de Insectos Asociados con la Planta *Jatropha gossypifolia* en el Perú", por el periodo comprendido entre febrero de 2013 hasta febrero de 2014;



Que, mediante Carta N°285-2013-AG-DGFFS-DGEFFS de fecha 28 de febrero de 2013 emitida por la Dirección de Gestión Forestal y de Fauna Silvestre, se solicitó al señor Kunjithapatham Dhileepan; subsanar las observaciones formuladas al expediente presentado; las cuales fueron absueltas conforme se desprende de las Cartas de fechas 25 de marzo y 01 de abril del presente año.

Que, el Decreto Supremo N° 014-2001-AG, que aprueba el Reglamento de la Ley Forestal y de Fauna Silvestre, establece en su artículo 328° que la investigación científica o estudio que implique colección de especímenes o elementos de la flora y fauna silvestre no vedados y la obtención de datos e información de campo, requiere autorización del INRENA;

Que, el Decreto Supremo N° 003-2009-MINAM, que aprueba el Reglamento de Acceso a los Recursos Genéticos, indica en su Tercera Disposición Final que la obtención de permisos, autorizaciones y demás documentos que otorguen entidades públicas, tales como el Ministerio de Agricultura, y que amparen la investigación, obtención, provisión, transferencia u otro de recursos biológicos, con fines distintos a su utilización como fuente de recursos genéticos, no faculta a sus titulares a utilizar dichos recursos como medio para acceder a los recursos genéticos, ni determinan ni presumen autorización de acceso;



Que, la Resolución Ministerial N° 212-2011-AG que aprueba la modificación al Texto Único de Procedimientos Administrativos (TUPA) del Ministerio de Agricultura, establece en su numeral 21, los requisitos para la Autorización de actividades de investigación científica y filmaciones con fines comerciales de flora y fauna silvestre fuera de Áreas Naturales Protegidas;

Que, el Informe N° 1465 - 2013-AG-DGFFS-DGEFFS, de fecha 07 de mayo 2013, emitido por la Dirección de Gestión Forestal y de Fauna Silvestre de la Dirección General Forestal y de Fauna Silvestre, concluye que el estudio reviste de importancia puesto que permitirá obtener mayor información de los insectos y ácaros asociados con *Jatropha gossypifolia* en el Perú, identificándose como posibles agentes de control biológico;

Que, el referido Informe señala que la solicitud materia de resolución, cumple con los requisitos establecidos por el Texto Único de Procedimientos Administrativos del Ministerio de Agricultura, para obtener la autorización petitionada. Asimismo teniendo en cuenta los objetivos y metodologías presentadas; se recomienda otorgar la Autorización de investigación por el período de un año, contado a partir de la emisión de la presente Resolución, además se recomienda autorizar la colecta de insectos y ácaros asociados a la especie *Jatropha gossypifolia*, Teniendo en cuenta sus tasas reproductivas y que no se encuentran en ninguna categoría de amenaza, se considera procedente no restringir su colecta;



En uso de las atribuciones conferidas por el artículo 61° del Decreto Supremo N° 031-2008-AG, que aprueba el Reglamento de Organización y Funciones del Ministerio de Agricultura; que en su inciso n) precisa como funciones de la Dirección de Gestión Forestal y de Fauna Silvestre la de autorizar la extracción de especímenes de flora, fauna silvestre y microorganismos con fines de investigación;

**SE RESUELVE:**

**Artículo 1°.-** Autorizar a la señor Kunjithapatham Dhileepan, la investigación científica en flora y fauna silvestre, la colecta de insectos y ácaros asociados a la especie *Jatropha gossypifolia*; fuera de Áreas Naturales Protegidas en los departamentos de San Martín e Iquitos; como parte del proyecto "Exploración e Identificación de Insectos Asociados con la Planta *Jatropha gossypifolia* en el Perú" por el período de un año, contado a partir de la emisión de la presente Resolución; en el cual participarán los siguientes profesionales:

Nombre	Documento	Número
Kunjithapatham Dhileepan	Pasaporte	N4708146
Jeferson Alberto Suárez de la Cruz	DNI	42738444



**Artículo 2°.-** El titular y el investigador autorizados se compromete a:

- a) Colectar únicamente los especímenes autorizados.
- b) No ceder el material colectado a terceros.
- c) Entregar el 50% del material colectado por tipo de muestra a una institución científica nacional debidamente reconocida. Los ejemplares únicos de los grupos taxonómicos colectados y holotipos, sólo podrán ser exportados en calidad de préstamo.
- d) El material debe ser depositado debidamente preparado e identificado, o de lo contrario, los investigadores que realicen el depósito deberán sufragar los gastos que demanden la preparación del material para su ingreso a la colecta correspondiente.
- e) No contactar, ni ingresar a los territorios comunales sin contar con la autorización de las autoridades comunales correspondientes.
- f) Entregar a la Dirección General Forestal y de Fauna Silvestre dos (02) copias del informe final en idioma español, como resultado de la autorización otorgada, copias del material fotográfico y/o slides que puedan ser utilizadas para difusión. Asimismo, entregar tres (03) copias de las publicaciones, producto de la investigación realizada en formato impreso y digital, que incluya la lista taxonómica de las especies de fauna y flora objeto de la presente autorización de colecta con las respectivas coordenadas (en formato excel).
- g) Indicar el número de la Resolución en las publicaciones generadas a partir de la autorización concedida.



**Artículo 3°.-** La Dirección de Gestión Forestal y de Fauna Silvestre no se responsabiliza por accidentes o daños sufridos por el solicitante de esta autorización, durante la ejecución del proyecto.

**Artículo 4°.-** Los derechos otorgados sobre los recursos biológicos no otorgan derechos sobre los recursos genéticos contenidos en ellos, de acuerdo a lo señalado en el literal f) del artículo 1° del Reglamento de la Ley Forestal y de Fauna Silvestre, aprobado por Decreto Supremo N° 014-2001-AG. Asimismo, de acuerdo a lo dispuesto por la Tercera Disposición Final del Reglamento de Acceso a Recursos Genéticos, aprobado por Resolución Ministerial N°087-2008-MINAM, la cual fue elevada a rango de Decreto Supremo por el Decreto Supremo N° 003-2009-MINAM, la obtención de permisos, autorizaciones y demás documentos que otorguen entidades públicas tales como el Ministerio de Agricultura, y que amparen la obtención de recursos biológicos, con fines distintos a su utilización como fuente de recursos genéticos, no faculta a sus titulares a utilizar dichos recursos como medio para acceder a los recursos genéticos, ni determinan, condicionan ni presumen la autorización de acceso.

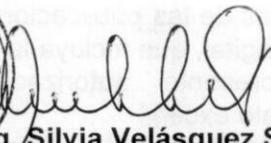
**Artículo 5°.-** El incumplimiento de los compromisos adquiridos, podrá ser causal para denegar futuras autorizaciones a nivel institucional.



**Artículo 6°.-** Notificar la presente resolución al señor Kunjithapatham Dhileepan; transcribirla a la Dirección de Información y Control Forestal y de Fauna Silvestre; a la Administración Técnica de Cajamarca; a la Dirección de Recursos Naturales y Asuntos Ambientales Agrarios del Gobierno Regional de San Martín y a la Dirección Ejecutiva Regional del Programa Regional de Manejo de Recursos Forestales y de Fauna Silvestre del Gobierno Regional de Loreto.

Regístrese y comuníquese



  
**Abog. Silvia Velásquez Silva**  
Directora de Gestión Forestal y de  
Fauna Silvestre (e)

## **Appendix 2. South America travel itinerary**

Department of Agriculture, Fisheries and Forestry, Biosecurity Queensland,  
Invasive Plant & Animal Science, EcoSciences Precinct, Boggo Road, Brisbane

## - Trip Itinerary -

DAFF Officer Surname:	First Name:	Work Telephone No.:	Home Telephone No.:
Dhileepan	Kunjithapatham	32554449	38767991
Emergency Contact (Next of Kin) Surname:	First Name:	Work Telephone No.:	Home Telephone No.:
Dhileepan	Geetha	3371 4144	3876 7991
Next of Kin's Address:			
210 Stanley Terrace, Taringa, Qld 4068			

### Trip Itinerary (if insufficient space please attach detailed schedule)

Date:	From:	To:	Flight No.	Depart	Arrive	Organisation	Contact Ph #: (Host organisation)	Accommodation	Phone No. (personal mobile)
3/3/2013	Brisbane	Auckland (New Zealand)	QF123	08:20	14:35				Global roaming: 0403573634
3/3/2013	Auckland	Santiago (Chile)	QF321	16:50	11:35				Global roaming: 0403573634
3/3/2013	Santiago (Chile)	Lima (Peru)	LA632	14:55	16:50	Departamento de Entomologia, Museo de Historia Natural, UNMSM, Av. Arenales 1256, Apartado 14-0434, Lima, Peru	Dra. Diana Silva Davila (dianasil@gmail.com)	Local hotel/motel Lima (Peru)	Global roaming: 0403573634
4/3/2013	Lima (Peru)	Tarapoto (Peru)	LA2256	20:10	21:35	Survey in Lima	As above	Local motel/hotel Tarapoto	Global roaming: 0403573634
5/3/2013	Tarapoto	Local visit	By land - car	09:00	18:00	Roadside surveys	As above	Local motel/hotel Tarapoto	Global roaming: 0403573634
6/3/2013	Tarapoto	Moyobamba (Peru)	By land - car	09:00	18:00	Roadside surveys	As above	Local motel/hotel Moyobamba	Global roaming: 0403573634
7/3/2012	Moyobamba	Juanjui (Peru)	By land - car	09:00	18:00	Roadside surveys	As above	Local hotel/motel Juanjui	Global roaming: 0403573634
8/3/2013	Juanjui	Tocache Nuevo (Peru)	By land - car	09:00	18:00	Roadside surveys	As above	Local hotel/motel Tocache Nuevo	Global roaming: 0403573634
9/3/2012	Tocache Nuevo	Juanjui	By land - car	09:00	18:00	Roadside surveys	As above	Local hotel/motel Juanjui	Global roaming: 0403573634
10/3/2013	Juanjui	Tarapoto	By land - car	09:00	18:00	Roadside surveys	As above	Local motel/hotel Tarapoto	Global roaming: 0403573634
11/3/2013	Tarapoto	Iquitos (Peru)	LA2390	16:30	17:45	Survey in Tarapoto	As above	Local motel/hotel Iquitos	Global roaming: 0403573634

12/3/2013	Iquitos	Travel to Nauta (Peru) and back to Iquitos	By land - car	09:00	18:00	Roadside surveys		Local motel/hotel Iquitos	Global roaming: 0403573634
13/3/2013	Iquitos	Lima	LA2379	21:30	23:30	Survey in Iquitos			Global roaming: 0403573634
14/3/2013	Lima	La Paz (Bolivia)	LA2561	01:30	04:30	Seccion de Invertebrados, Coleccion Bolivian de Fauna, Calle 27, Cota Cota, La Paz, Bolivia	Dr. Miguel Limachi Tel: 591-2-2792416 Mob: 72091886	Local motel/hotel La Paz	Global roaming: 0403573634
15/3/2013	La Paz	Oruro (Bolivia)	By land - car	09:00	18:00	Roadside surveys	As above	Local motel/hotel Oruro	Global roaming: 0403573634
16/3/2013	Oruro	Rio Mulatos (Bolivia)	By land - car	09:00	18:00	Roadside surveys	As above	Local motel/hotel Rio Mulatos	Global roaming: 0403573634
17/3/2013	Rio Mulatos	Oruro	By land - car	09:00	18:00	Roadside surveys	As above	Local motel/hotel Oruro	Global roaming: 0403573634
18/3/2013	Oruro	Cochabamba (Bolivia)	By land - car	09:00	18:00	Roadside surveys	As above	Local motel/hotel Cochabamba	Global roaming: 0403573634
19/3/2013	Cochabamba	Comarapa (Bolivia)	By land - car	09:00	18:00	Roadside surveys	As above	Local motel/hotel Comarapa	Global roaming: 0403573634
20/3/2013	Comarapa	Santa Cruz (Bolivia)	By land - car	09:00	18:00	Roadside surveys	As above	Local motel/hotel Santa Cruz	Global roaming: 0403573634
21/3/2013	Santa Cruz	Local surveys around Santa Cruz	By land - car	09:00	18:00	Surveys Montero and Puerto Banegas (Bolivia).	As above	Local motel/hotel Santa Cruz	Global roaming: 0403573634
22/3/2013	Santa Cruz	Surveys in Santa Cruz	By land - car	09:00	18:00	Surveys in Santa Cruz	As above	Local motel/hotel Santa Cruz	Global roaming: 0403573634
23/3/2013	Santa Cruz	Asuncion (Paraguay)	PZ701	13:40	16:25	Museo Nacional de Historia Natural de Paraguay, San Lorenzo, Paraguay	Dr Carlos Aguilar Julio Tel: 021-585208 Mob: (09891) 257987	Local motel/hotel Asuncion	Global roaming: 0403573634
24/3/2013	Asuncion	Local survey	By land - car	09:00	18:00	Survey in Asuncion	As above	Local motel/hotel Asuncion	Global roaming: 0403573634
25/3/2013	Asuncion	Caazapá (Paraguay)	By land - car	09:00	18:00	Surveys in Cerro Acahay, Paraguari and Caazapá	As above	Local motel/hotel Caazapá	Global roaming: 0403573634
26/3/2013	Caazapá	Villarrica (Paraguay)	By land - car	09:00	18:00	Surveys in Tapyta and Villarrica.	As above	Local motel/hotel Villarrica	Global roaming: 0403573634
27/3/2013	Villarrica	Coronel Oviedo (Paraguay)	By land - car	09:00	18:00	Surveys in Caaguazú and Coronel Oviedo.	As above	Local hotel. motel Coronel Oviedo	Global roaming: 0403573634
28/3/2013	Coronel Oviedo	Asuncion	By land - car	09:00	18:00	Roadside survey	As above	Local hotel/motel Asuncion	Global roaming: 0403573634

29/3/2013	Asuncion	Santiago (Chile)	LA5911	12:05	13:45			Day accommodation in Santiago	Global roaming: 0403573634
29/3/2013	Santiago	Auckland	QF322	22:20	04:30 (31/3/2012)				Global roaming: 0403573634
31/3/2012	Auckland	Brisbane	QF124	06:15	07:10				Global roaming: 0403573634

### Other contacts

Name	Organisation	Phone No.
Dra. Diana Silva Davila	Departamento de Entomologia, Museo de Historia Natural, UNMSM, Av. Arenales 1256, Apartado 14-0434, Lima, Peru	Email: <a href="mailto:dianasil@gmail.com">dianasil@gmail.com</a>
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