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New insights on the mistletoe *Tristerix aphyllus* (Loranthaceae): interaction with diurnal and nocturnal frugivorous species

Nuevas evidencias sobre el muérdago *Tristerix aphyllus* (Loranthaceae): interacción con especies frugívoras diurnas y nocturnas

Francisco Lucero, Carezza Botto-Mahan, Rodrigo Medel & Francisco E. Fontúrbel*

Departamento de Ciencias Ecológicas, Facultad de Ciencias, Universidad de Chile, Casilla 653, Santiago, Chile.
*fonturbel@ug.uchile.cl

RESUMEN

Se estudiaron los visitantes de las infrutescencias de *Tristerix aphyllus*, un muérdago parásito de cactáceas. La mayoría de los visitantes fueron aves diurnas (cinco especies), especialmente el dispersor legítimo *Mimus thenca*. También se registraron dos especies de pequeños mamíferos nocturnos, llamando la atención el marsupial *Thylamys elegans*, cuyo rol como dispersor es aún desconocido.

Tristerix aphyllus (DC.) Barlow et Wiens (Loranthaceae) is a leafless mistletoe endemic of the arid and semiarid regions of Chile, which only parasitizes species of the Cactaceae family, mainly of the genera *Echinopsis* and *Eulychnia*, and occasionally *Opuntia* and *Copiapoa*. The blooming period of *T. aphyllus* ranges from March to August, and the fruiting period extends from late March to late November, with a peak of fruit production between July and September (Medel 2000, Medel *et al*. 2002). *Tristerix aphyllus* presents unique adaptations for arid environments and host infection. Its vegetative portion remains completely inside the cactus host, being the only leafless species within the family. This mistletoe adheres to the host phloem, not to the xylem as most mistletoes, emerging out only the reproductive structures (i.e., flowers and fruits) (Medel *et al*. 2002). Diurnal recordings indicate that *T. aphyllus* is almost exclusively dispersed by the mimid *Mimus thenca* (Mimidae, Molina 1782) in central Chile (Martínez del Río *et al.* 1996, Medel 2000). This observation differs from an equivalent mistletoe-disperser system present in the temperate forests of southern South America (Argentina and Chile), which is composed by the hemiparasitic mistletoe *Tristerix corymbosus* and the relict marsupial *Dromiciops gliroides* (Amico & Aizen 2000, Fontúrbel *et al*. 2012). As *D. gliroides* is not present at lower latitudes but replaced by the marsupial *Thylamys elegans* (Didelphidae, Waterhouse 1839), it is likely that this nocturnal species is involved in the seed dispersal process of the leafless mistletoe in central Chile. This study presents by the first time quantitative information on the diurnal and nocturnal frugivorous assemblage of *T. aphyllus*.

This study was conducted at the Reserva Nacional Las Chinchillas (31º 30' S, 71º 06' W), which is located ~300 km northern from Santiago, Chile. The sampling was carried out by using 24 infrared camera-traps placed in front of *T. aphyllus* infructescences protruding from columns of the cactus *Echinopsis chiloensis* (Colla) Friedrich & G.D.Rowley, as was previously conducted by Amico *et al.* (2011) for *T. corymbosus*. The cameras were set on July 11th and removed on September 14th, covering the peak of fruit production in the site (Medel *et al*. 2002). The camera-traps are activated by motion and are able to record night pictures or short videos without using flash to avoid disturbing the visitors. The cameras were set on photographic mode (5 Megapixel of resolution) with 1 min delay between shots to reduce the chance of recording repeated pictures from the same visit event. Then, four cameras were left in video mode (15s length, 1 min delay) for four weeks (September 15th to October 13th), monitoring those plants where small mammals were detected. Each picture and short video included the exact date and time.

For infructescences 372 visits we recorded, corresponding to seven species (Fig. 1), five bird and two small mammal species. In decreasing order of visitation they were: 295 *M. thenca* (79.3%), 53 *Diuca diuca* (14.2%) (Molina 1782), 15 *Phrygilus gayi* (4.0%) (Gervais 1834), three *Phyllotis darwini* (1.0%) (Waterhouse 1837), two *Pseudasthenes humicola* (0.5%) (Kittlitz 1830), two *Leptasthenura aegithaloides* (0.5%) (Kittlitz 1830), and two *T. elegans* (0.5%). Only four species were recorded consuming the whole or part of *T. aphyllus* fruits: *M. thenca*, *D. diuca*, *P. gayi* and *L. aegithaloides*. The visits of all of the five bird species were recorded between the 7:00 and 18:30 h, whereas small mammal visits occurred between 1:30 and 6:00 h (Fig. 2a). The activity of all visitors showed ample temporal variation (Fig. 2b).

The results showed that from the total of bird visits, almost 80% corresponded to the legitimate disperser *M. thenca* (Medel 2000), and the remaining 20% corresponded to species whose role in seed dispersal is still unknown. *Mimus thenca* also disperses the seeds of the hemiparasitic mistletoe *T. corymbosus* at this same study area, which is also visited by the frugivorous birds *Elaenia albiceps* and *Turdus falcklandii* at Chilean matorral (Amico *et al.* 2011), bird species which were not recorded visiting *T. aphyllus*.

Diuca diuca, *P. gayi* and *L. aegithaloides* were recorded consuming fruits of *T. aphyllus*, but their efficiencies as seed dispersers are largely unknown at present. Considering that those bird species may be precluded to consume *T. aphyllus* fruits by morphological restrictions (i.e., bill width), it is likely that they act as pulp consumers only. Regarding activity patterns, birds visited *T. aphyllus* during daytime and small mammals at night, which is a common pattern in nature. The results confirm previous assertions that *M. thenca* is the most important frugivorous species in this system. In addition, our video recordings suggest that *D. diuca* (and other small-bodied birds such as *L. aegithaloides* and *P. humicola*) may contribute to cactus re-infection, by acting as pulp consumers and therefore dropping the intact sticky seeds after ingestion of the fruit pericarp, which may enhance seed germination (Gonzales *et al*. 2007) (video available at http://youtu.be/k9Fib3AjRoc). It is common for fleshy-fruited plants to be visited by many animal species, which largely differ in visit frequency and quality (Schupp *et al.* 2010). This seems to be the case of *T. aphyllus*, in which one species (*M. thenca*, video available at http://youtu.be/fQdebqbwC2A) is responsible of most dispersal, whereas the remaining species might be casual or less efficient visitors, and other are just pulp consumers (e.g., rodents, video available at http://youtu.be/HPI2nY4VnQM). Finally, even though the marsupial *T. elegans* visited infructescences of *T. aphyllus*, its low occurrence contrasts with the interaction between *Tristerix corymbosus* and *Dromiciops gliroides* in temperate forests. The low frequency of interaction in this study may result from a spatial mismatch between *T. elegans* and the cacti parasitized by *T. aphyllus*. In the study site, *T. elegans* predominantly inhabits polar-facing slopes (which offer better microclimate conditions explaining its presence on late winter), whereas cacti inhabit equatorial-facing slopes, overlapping only in a narrow portion of ravine habitats (C. Botto-Mahan, unpublished data). Therefore, it is necessary to direct sampling efforts to ravine habitats to get more video recordings under natural conditions, which would help to determine whether this marsupial behaves as an effective seed disperser and the magnitude of the marsupial-mistletoe interaction.

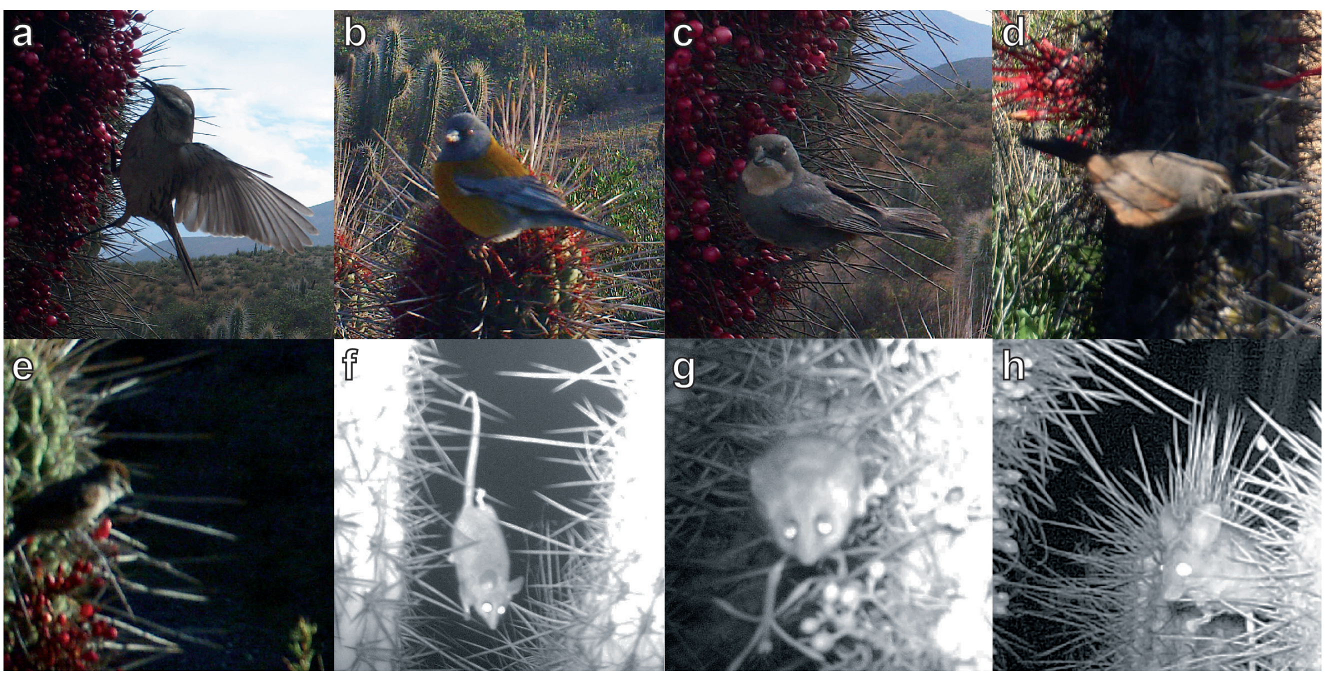

Figure 1: Species registered visiting *Tristerix aphyllus* infructescences: (a) *Mimus thenca*, (b) *Phrygilus gayi* (c) *Diuca diuca*, (d) *Pseudasthenes humicola,* (e) *Leptasthenura aegithaloides*, (f-g) *Thylamys elegans*, and (h) *Phyllotis darwini*.

Figura 1: Especies registradas visitando las infrutescencias de *Tristerix aphyllus*: (a) *Mimus thenca*, (b) *Phrygilus gayi,* (c) *Diuca diuca*, (d) *Pseudasthenes humicola,* (e) *Leptasthenura aegithaloides*, (f-g) *Thylamys elegans* y (h) *Phyllotis darwini*.

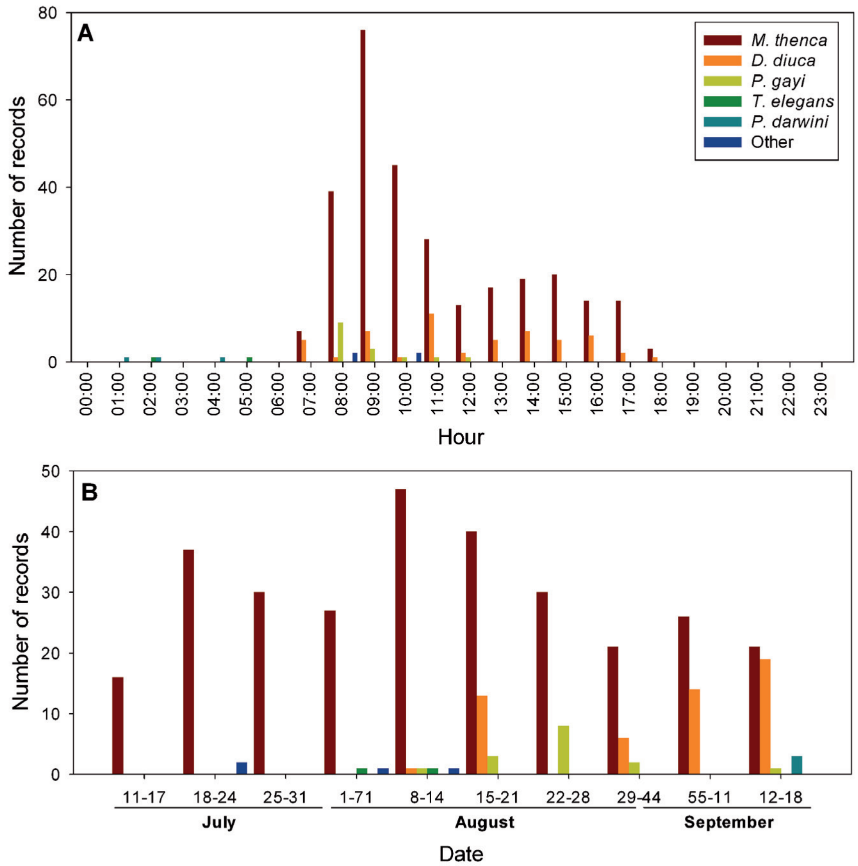

Figure 2: Activity of the registered species by (a) hour and (b) date.

Figura 2: Actividad de las especies registradas por (a) hora y (b) fecha.

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