Revista Chilena de Historia Natural
a SpringerOpen Journal

SHORT REPORT Open Access

Host plant specificity of the moth species *Glena mielkei* (Lepidoptera, Geometridae) in northern Chile

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Abstract

Background: Host plant specificity refers to the preference of insects for particular plant species that allow them to complete their life cycle. Moth species of the Geometridae family depend closely on the vegetation composition to complete their life cycles. In northern Chile, the Geometridae species *Glena mielkei* is the only species described of the genus Glena. So far, this species has only been associated to a single host plan species of the Asteraceae family, *Trixis cacalioides*. The aim of this study was to determine the suitability of five commonly occurring plant species of Asteraceae as hosts for *G. mielkei*.

Findings: We collected *G. mielkei* larvae from *T. cacalioides* plants occurring in the Azapa valley and reared them in the laboratory. We tested host plant suitability by exposing recently lab-reared adults of *G. mielkei* to the following Asteraceae species: *T. cacalioides*, *Pluchea chingollo*, *Baccharis salicifolia*, *Grindelia tarapacana* and *Tessaria absinthioides*. Larvae fed with *G. tarapacana* died of starvation within four to five days. Larvae fed with *B. salicifolia* fed partially on the plant but died within the first and third day. Larvae fed with both plant species did not complete their development. Larvae fed with *T. cacalioides*, *P. chingollo* and *T. absinthioides* developed into adult stages, producing viable progeny.

Conclusions: We found *T. cacalioides*, *P. chingollo* and *T. absinthioides* to be suitable hosts for *G. mielkei*. None of the larvae fed on *G. tarapacana* and *B. salicifolia* completed their life cycle. We conclude that this narrow range of host plants potentially threatens *G. mielkei* given the continuous loss of its host plants and feeding sources due to habitat loss and agricultural activities.

Keywords: Asteraceae; Azapa; Chaca; Geometridae

Findings

In terms of insect-plant relationships, the concept of host plant specificity has been developed on the fact that in order to be a host plant, the plant has to generate the necessary stimuli to allow an herbivore insect to find it and utilise it as an appropriate substrate (Awmack and Leather 2002) to complete its development. The suitability of a host plant has also been discussed in terms of the capacity of the plant to shelter natural enemies that could potentially prevent the establishment of the phytophagous insects (Nomikou et al. 2003) and to produce chemical compounds that may potentially be identified by the phytophagous insect (Rajapakse et al. 2006).

In a narrower context, host plant specificity has focused on the preference of insects to feed on a particular plant species (Novotny and Basset 2005). Hence, depending on the number of host plant species insects can feed on, phytophagous insects have been classified as monophagous, oligophagous and polyphagous (Cates 1980, Symons and Beccaloni 1999). On the other hand, and based on the quality to sustain the development of phytophagous insects, host plants have been classified into two main types: primary host plants and secondary or incidental host plants (Manners et al. 2010). Primary host plants refer to plants that provide all the necessary conditions for the successful completion of the life cycle of herbivores associated to them and also to those that are an appropriate feeding substrate to the herbivore species in question (Rajapakse et al. 2006, Manners et al. 2010). In contrast, secondary or incidental host plants

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have only some features of the primary host plant and are normally used in lower numbers (Milne and Walter 2000, Novotny and Basset 2005, Manners et al. 2011). Within this context, relationships between phytophagous insects and their host plants have been initially studied from distributional data collected from natural environments (e.g. tropical forests), having moved into more species-focused data obtained from specimens observed *in situ* or reared in the laboratory (Novotny and Basset 2005).

The Geometridae family is a highly diverse family of Lepidoptera whose species are mainly herbivorous (Scoble 1995, Axmacher et al. 2009) and closely related to the vegetation (Scoble 1995, Brehm and Fiedler 2005, Brehm et al. 2005). Species belonging to this family are also known to be associated to a relatively small range of host plants (Bolte 1990, Bodner et al. 2010). This is of particular importance when considering the conservation of vegetation and the insect fauna associated to it in highly disturbed areas (Brehm and Fiedler 2005, Sutrisno 2007). In this regard, the vegetation of the coastal valleys of northern Chile, particularly the Arica and Parinacota Region, represent clear examples of areas where a vast amount of native vegetation has been removed and replaced by agricultural land (Luebert and Pliscoff 2006).

In northern Chile, the plant family most frequently used as host by geometrid larvae is Fabaceae (Vargas and Parra 2004, 2005, Vargas et al. 2005, Vargas 2007); however, Anacardiaceae, Asteraceae and Nyctaginaceae have been also recorded as host in the Azapa valley (Vargas et al. 2010, Vargas 2011, Vargas 2014). In addition to their trophic associations with the vegetation, geometrid moths also play an important role as prey items for predatory insects. An example of such association is the potter wasp *Hypodynerus andeus* (Packard). In the Azapa valley, the larval stages of *H. andeus* feed almost exclusively on geometrid larvae (Méndez-Abarca et al. 2012).

A total of 30 species of the genus *Glena* Hulst have been described in South America (Pitkin 2002). In the case of Chile, only one species of this genus has been described: *Glena mielkei* Vargas. *G. mielkei* is a species whose distribution has been found to be mostly restricted to the Azapa and Chaca valleys in the Arica Province. So far, this species has been known to be associated only to a single host plant species of the Asteraceae family, *Trixis cacalioides* (Kunth) (Vargas 2010). The aim of this note is to determine the host plant specificity of *G. mielkei* in five plant species of the Asteraceae family in laboratory conditions.

G. mielkei larvae were collected from individuals of *T. cacalioides* plants naturally occurring in the Azapa valley (18°31′36.38″S-70°9′59.68″O). Larvae collection was carried out manually between March and December 2012. Samples were transported to the laboratory at the Faculty of Agricultural Sciences, Universidad de Tarapacá to be reared in the laboratory under ambient temperature, humidity and normal day-night photoperiod. In order to obtain adults of *G. mielkei*, a total of 50 larvae were kept in 200 mL plastic vials and fed with fresh leaves of *T. cacalioides* until adults were obtained. We carried out three simultaneous replicates of this experiment. Once emerged, adults were kept in plastic bags with leaves of *T. cacalioides* to allow mating and egg lying. We selected the following plant species to test their suitability as host plants for individuals of *G. mielkei*: *T. cacalioides*, *Pluchea chingollo* (Kunth), *Baccharis salicifolia* (Ruiz and Pav.), *Grindelia tarapacana* (Phil) and *Tessaria absinthioides* (Hook. and Arn.). These selected plant species are all of common occurrence in the Azapa valley (Katinas 2011; Luebert 2004; Ferrú and Elgueta 2011; Muñoz Ovalle 2010). Larvae were carefully handled with a fine brush that allowed silk threads to stick to it and avoid any kind of damage to the larvae. Five larvae were located in 20 × 20 cm transparent plastic bags to feed on leaves of each plant species. Larvae were kept in the laboratory at ambient temperature, humidity and normal day-night photoperiod.

Larvae fed on all species of plant offered except for *G. tarapacana*, whose leaves remained untouched. Larvae fed with this plant died of starvation within 4 to 5 days. Larvae fed with *B. salicifolia* partially accepted the feeding substrate but died within the 1st and 3rd day. Larvae fed with these two plant species did not complete their development. On the other hand, larvae fed with *T. cacalioides*, *P. chingollo* and *T. absinthioides* developed into adult stages, producing viable progeny (see Table 1). The experiment lasted for a month.

As stated in Vargas (2010), larvae of *G. mielkei* fed with leaves of the native shrub *T. cacalioides* developed normally producing viable and fertile progeny. So far, there have been no records of larvae of *G. mielkei* feeding on other Asteraceae species, apart from *T. cacalioides,* in the coastal valleys of the Arica Province. Our findings expand the range of hosts that can be used for

Table 1 Life-cycle development of *G. mielkei* larvae fed with five Asteraceae plant species

Host plant	Larvae developed into adult stage	Reared adults produced viable progeny
Trixis cacalioides	X	X
Pluchea chingollo	X	X
Baccharis salicifolia		
Grindelia tarapacana		
Tessaria absinthioides	X	X

The five Asteraceae plant species are commonly found on the coastal valleys of the Arica Province, Chile. X= Indicates plant species where larvae managed to develop into adults or to produce viable progeny.

G. mielkei as potential food sources. We found that, besides *T. cacalioides*, two other Asteraceae species appeared to be suitable feeding sources for *G. mielkei*: *P. chingollo* and *T. absinthioides*. Larvae reared in both plant species completed their development into adults and produced viable progeny. Measured larval size was 3 (±0.2) mm for first instar larvae. The recorded pupal size was 20(±0.2) mm ($n = 150$). The development period recorded for each larval instar lasted 5(±1) days from egg to first instar, 5(±1) days from first to second instar, 3(±1) days from second to third instar, 3(±1) days from third to fourth instar, 4(±1) days from fourth to fifth instar, 5(±1) days from fifth instar to pupa and 15(±1) days from pupae to adults ($n = 150$). This can be considered a reliable indicator of their suitability as food sources for *G. mielkei*.

The distribution of *G. mielkei* is known to be restricted to the valleys of Azapa and Chaca in the Arica Province (Vargas 2010). Intensive agriculture has caused fragmentation, destruction and replacement of the native vegetation in these coastal valleys (Latorre 2013; Luebert and Pliscoff, 2006; Valenzuela et al., 2004). Geometridae larvae are in general more sedentary and tend to be less capable of dispersing when their habitat is severely disturbed (Thomas 2002). Hence, a species like *G. mielkei*, with a narrow range of host plants, could be easily threatened by the continuous loss of its host plants and feeding sources, such as the case of the species *Glena cognataria* (Guenée), a species that strongly depends on shrubland habitats in southern New England and south-eastern New York, USA (Wagner et al. 2003). It is well known that in some cases host plant selection behaviour in the laboratory may differ from the host plant selection in the field (Stoeva et al. 2012) as many other environmental factors, such as altitude, latitude and temperature, can influence host plant selection (Scriber 2002). A logical step towards improving the understanding of the relationships of *G. mielkei* with its host plants should be to study host plant use in the field, particularly in scenarios where potential host plants could occur simultaneously.

Competing interests
The authors declare that they have no competing interests.

Authors' contributions
FM-A conducted the main field and laboratory work and drafted the manuscript. CM assisted field and laboratory work. EM collaborated with drafting and providing critical comments on the manuscript. All authors read and approved the final manuscript.

Acknowledgements
To Universidad de Tarapacá and to the project UTA DIEXA 9711-11 for the funding and to Dr. Héctor A. Vargas, from the Faculty of Agricultural Sciences of Universidad de Tarapacá, for his support.

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Received: 9 May 2014 Accepted: 22 October 2014
Published online: 07 November 2014

References
Awmack CS, Leather SR (2002) Host plant quality and fecundity in herbivorous insects. Annu Rev Ent 47:817–844

Axmacher JC, Brehm G, Hemp A, Tünte H, Lyaruu H, Müller-Hohenstein V, Fiedler K (2009) Determinants of diversity in afrotropical herbivorous insects (Lepidoptera: geometridae): plant diversity, vegetation structure or abiotic factors? J Biogeogr 36:337–349

Bodner F, Brehm G, Homeier G, Strutzenberger J, Fiedler K (2010) Caterpillars and host plant records for 59 species of geometridae (Lepidoptera) from a montane rainforest in southern Ecuador. J Insect Sci 10:1–22

Bolte KB (1990) Guide to the geometridae of Canada (Lepidoptera). VI subfamily larentiinae.1 revision of the genus *eupithecia*. Mem entom Soc Can 151:1–253

Brehm G, Fiedler K (2005) Diversity and community structure of geometrid moths of disturbed habitat in a montane area in the Ecuadorian Andes. J Res Lep 38:1–14

Brehm G, Pitkin LM, Hilt N, Fiedler K (2005) Montane Andean rain forests are a global diversity hostpot of geometrid moths. J Biogeogr 32:1621–1627

Cates RG (1980) Feeding patterns of monophagous, oligophagous, and polyphagous insect herbivores: the effect of resource abundance and plant chemistry. Oecologia 46:22–31

Ferrú MA, Elgueta M (2011) Lista de coleópteros (Insecta: coleoptera) de las regiones de Arica y parinacota y de Tarapacá, Chile. Bol Mus Nac Hist Nat 60:9–61

Katinas L (2011) Revisión de las especies sudamericanas del género *Trixis* (asteraceae, mutisieae). Darwiniana, nueva serie 34:27–108

Latorre L (2013) Propuesta de plan de ordenamiento predial para la conservación en la localidad de Chaca, Región de Arica y Parinacota. Universidad de Chile, Tesis Doctoral

Luebert F (2004) Apuntes sobre la vegetación de bosque y matorral del desierto precordillerano de Tarapacá (Chile). Chloris Chilensis 7:1

Luebert F, Pliscoff P (2006) Sinopsis bioclimática y vegetacional de Chile. Editorial Universitaria, Santiago, Chile

Manners A, Palmer G, Dhileepan WA, Hastwell K, Walter GH (2010) Characterising insect plant host relationships facilitates understanding multiple host use. Arthropod Plant Interact 4:7–17

Manners A, Palmer G, Burgos WA, McCarthy A, Walter GH (2011) Relative host plant species use by the lantana biological control agent *Aconophora compressa* (Membracidae) across its native and introduced ranges. Biol Control 58:262–270

Méndez-Abarca F, Mundaca EA, Vargas HA (2012) First remarks on the nesting biology of *hypodynerus andeus* (packard) (hymenoptera, vespidae, eumeninae) in the azapa valley, northern Chile. Rev Bras Entomol 56:240–243

Milne M, Walter GH (2000) Feeding and breeding across host plants within a locality by the widespread thrips Frankliniella schultzei, and the invasive potential of polyphagous herbivores. Divers Distrib 6:243–257

Muñoz Ovalle I (2010) Explotación de los ecosistemas húmedos por los tempranos agricultores prehispánicos del valle de Azapa. Idesia 28:107–115

Nomikou M, Janssen A, Sabelis MW (2003) Herbivore host plant selection: whitefly learns to avoid host plants that harbour predators of her offspring. Oecologia 136:484–488

Novotny V, Basset Y (2005) Host specificity of insect herbivores in tropical forests. Proc R Soc Lond, B 272:1083–1090

Pitkin LM (2002) Neotropical ennomine moths: a review of the genera. Zool J Linn Soc 135:121–401

Rajapakse CNK, Walter GH, Moor CJ, Hull CD, Cribb BW (2006) Host recognition by a polyphagous lepidopteran (Helicoverpa armigera): primary host plants, host produced volatiles and neurosensory stimulation. Physiol Entomol 31:270–277

Scoble M (1995) The Lepidoptera: form function and diversity. Oxford University Press, New York

Scriber JM (2002) Latitudinal and local geographic mosaics in host plant preferences as shaped by thermal units and voltinism in *Papilio* spp. (Lepidoptera). Eur J Entomol 99:225–239

Stoeva A, Harizanova V, De Lillo E, Cristofaro M, Smith L (2012) Laboratory and field experimental evaluation of host plant specificity of *Aceria solstitialis*, a

prospective biological control agent of yellow starthistle. Exp Appl Acarol 56:43–55
Sutrisno H (2007) Rapid assessment on macro-moth fauna at Nusa barong nature reserve: a low diversity. Berk Penel Hayati 12:115–120
Symons FB, Beccaloni GW (1999) Phylogenetic indices for measuring the diet breadths of phytophagous insects. Oecologia 119:427–434
Thomas AW (2002) Moth diversity in a northeastern North American, red spruce forest. II. The effect of silvicultural practices on geometrid diversity (Lepidoptera: Geometridae). Information Report M-X-213E. Canadian Forest Service – Atlantic Forestry Service, Fredericton, pp 1–25
Valenzuela D, Santoro CM, Romero A (2004) Arte rupestre en asentamientos del período Tardío en los valles de Lluta y Azapa, norte de Chile. Chungara 36:421–437
Vargas HA (2007) Dos nuevas especies de *iridopsis* warren (lepidoptera, geometridae) del norte de chile. Rev Bras Entomol 51:138–141
Vargas HA (2010) A new species of Glena hulst (Lepidoptera, geometridae) from northern Chile. Rev Bras Entomol 54:42–44
Vargas HA (2011) First host plant record of *Pero obtusaria* prout (Lepidoptera: geometridae). Neotrop Entomol 40:625–627
Vargas HA (2014) First host plant records for *iridopsis hausmanni* Vargas (Lepidoptera, geometridae) in the coastal valleys of northern Chile. Rev Bras de Entomol 58:95–97
Vargas HA, Parra LE (2004) Una nueva especie de *eupithecia* Curtis (lepidoptera: geometridae) del extremo norte de chile. Rev Chil Hist Nat 77:485–490
Vargas HA, Parra LE (2005) Descripción de una nueva especie de *eupithecia* Curtis (lepidoptera: geometridae) de la pampa del tamarugal, chile. Neotrop Entomol 34:215–219
Vargas HA, Parra LE, Hausmann A (2005) *Macaria mirthae*: una nueva especie de ennominae (lepidoptera: geometridae) de chile. Neotrop Entomol 34:571–576
Vargas HA, Mielke OHH, Casagrande MM, Parra LE (2010) Imaturos de *chrysmopterix undularia* (Blanchard) (lepidoptera, geometridae). Rev Bras Entomol 54:519–528
Wagner DL, Nelson MW, Schweitze DF (2003) Shrubland Lepidoptera of southern New England and southeastern New York: ecology, conservation, and management. Forest Ecol Manag 185:95–112

doi:10.1186/s40693-014-0022-2
Cite this article as: Méndez-Abarca *et al.*: **Host plant specificity of the moth species *Glena mielkei* (Lepidoptera, Geometridae) in northern Chile.** *Revista Chilena de Historia Natural* 2014 **87**:22.