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SCIENTIFIC NOTE

First record of *Myopa metallica* Camras, 1992 (Diptera: Conopidae: Myopinae) in Northern Chile after 46 years: A case study of the success of citizen science programs

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Abstract: The Wallacean shortfall is one of the most important problems regarding our knowledge of where and how to protect biodiversity. Citizen science programs can help fill this shortfall. A new record of the rare thick-head fly *Myopa metallica* Camras, 1992 is reported by a citizen science program from the Atacama desert after 46 years without new data and represents the second worldwide individual recorded of the species. We discuss the key role of the citizen science in the collection of new data on occurrence for rare and poorly known species.

Key words: Conopid endoparasitoid, Chile, citizen volunteer, Atacama Desert.

Data Text

Conopidae flies, sometimes called thick–head flies because of their chunky heads, include 683 described species, including fossil species (Stuke 2017). These species are conspicuous flies, distributed in all biogeographic areas, excluding Antarctica and Pacific Islands (Freeman 1996; Marshall 2012; Gibson *et al.* 2013; Stuke 2017). Here we do not follow the prevailing paradigm (Gibson *et al.* 2013; Stuke 2017) and instead treat the Conopidae minus *Stylogaster* (sensu Marshall 2012). This makes explanations of natural history and morphology more simple and efficient. Stylogasteridae is sister to Conopidae in this paradigm (Séguy 1946; Marshall 2012). In all species with known biology, Conopidae

flies are considered endoparasitoids of a wide range of aculeate bees, wasps or other flies, attacking in flight (Freeman 1996; Marshall 2012; Stuke 2017). This particular group of species and their host–parasite relationship has been studied by other authors (Schmid-Hempel *et al.* 1990; Maeta & Macrfarlane 1993; Freeman 1996; Otterstatter 2002) as well as ethological and ecological aspects as hilltopping mating behavior (Mei *et al.* 2010) and systematic and phylogenetic aspects (Gibson *et al.* 2010; Gibson & Skevington 2013). However, many species are nectarivorous and visit flowers as attack sites to prey on visitors (Marshall 2012).

Excluding the sister family, Conopidae is composed of six subfamilies: Conopinae, Dalmaniinae, Zodioninae, Notoconopinae, Palaeomyopinae (fossil) and Myopinae (Stuke 2017). In the subfamily Myopinae, the genus *Myopa* Fabricius 1775 has a mostly Holarctic distribution and was reviewed by Camras (1953) in the Nearctic region and by Stuke and Clements (2008) in the Palaearctic region. The review of Conopidae of the New World by Camras (1955) found no *Myopa* south of Mexico. However, in 1992, Camras described *Myopa metallica*, a remarkable metallic blue-reddish fly that was deposited in the Field Museum of Chicago from Metropolitan region in Chile and captured by Luis E. Peña in 1969. Forty-six years passed since this discovery until a new record of *M. metallica* was made in Chile, this time during a citizen science program on flies called *Moscas Florícolas de Chile.* The goal of this project is to gather distributional records for flower-visiting flies in Chile.

Citizen science is a social-biological discipline defined as volunteered collection of biodiversity and environmental data which contributes to expanding our knowledge of the natural environment, including biological monitoring and the collection or interpretation of environmental observations (Roy *et al.* 2012). Thus, citizen volunteers can be integrated in data collection, and receive positive feedback by scientists and therefore, their confidence and increase cooperation related to these projects (Cooper *et al.* 2007; Devictor *et al.* 2010). Many citizen science programs use their own web pages to collect information; but new endeavors have incorporated new tools towards this purpose using social networks such as Flickr, ISpot or Facebook (Dickinson *et al.* 2010; Stafford *et al.* 2010; Sequeira *et al.* 2014; Silvertown *et al.* 2015). Thus, by incorporating data gathered by citizens on the Facebook social network for *Moscas Floricolas de Chile* (www.facebook.com/groups/774986852548819/), the aim of this geographic note is to show the second record of *M. metallica*, with remarks on the natural history of this species and discussion of the pertinence of citizen science in the collection of new records of rare species.

Our citizen science program started in January 2015 and currently has 1800+ volunteers in Chile and several world specialists of Diptera. We used the social network Facebook as an internet platform to collect reports of several fly species using the *Group* tool. Participants are mainly naturalists, entomologists, undergraduate or graduate students, other professionals and photographers in concordance with Cohn (2008). The structure of this project is simple, as proposed by Devictor *et al.* (2010): we use a simple protocol to ask only three questions to all volunteers. The answers result in a dataset that includes: 1) the most specific possible location (or coordinates) for any flower fly species that the volunteer can facilitate; 2) date of the photographic report, and 3) the original picture of the fly that is being reported along with the flower/habitat visited. When necessary, the administrators ask volunteers for the missing data directly in their report; on many occasions feedback occurs, facilitating valuable extra information (Devictor *et al.* 2010).

For identifying species, we use in part, the morphological terminology of Camras (1992). Additionally, we compared our photographic record with the picture of the individual

type deposited on the Field Museum of Natural History of Chicago and we asked to a specialist in Conopidae (see acknowledgments).

Myopa metallica Camras, 1992

Diagnosis: Head, antennal segments and eyes rufous; hair in occiput, antennal area and mouth segments black; thorax and legs metallic black-blue with short hairs of the same color; wing base red-brownish mixed with dark color; halters conspicuous red. Second abdominal segment red-brownish, part of the first and third abdominal segment are the same color; other parts are metallic black-blue color; short hairs are black and distributed around abdomen (see Fig. 1).

Distribution: Quebrada de Ramón, Prov. Santiago, -33.441157S, -70.460221W, November 1969, coll. L.E. Peña (Type locality); 4 km N of town of Tal Tal, -25.378173S, -70.449766W (New locality); photographic coll. Maritza Zamora Gómez (Fig. 2).

Remarks: The habitat associated with the new record of *M. metallica* is coastal desert belonging to the biogeographical province of Atacama (Morrone 2001, 2004), a hyperarid and dry habitat with minimal annual precipitation (<10 mm) and morning fog called *Camanchaca*. Plants are scarce and have low richness. Vegetation occurs in small and dispersed patches, constituted principally by *Nolana*, *Tetragonia* and *Cistanthe* species. On the other hand, the type locality belongs to the Mediterranean Ecosystem of Central Chile and the biogeographical province of Santiago (Morrone 2001, 2004), with four stations clearly marked, with the rainy season concentrated between April-September and the dry season between October and March (Di Castri & Hajek 1976). The vegetation in this ecosystem is continuing in the rural areas, with several native and endemic plants in the dry montane area of the type locality. The richness of plants here is more higher than new record locality, with stationary shrubs such as *Baccharis*, *Adesmia*, *Colliguaja* and *Retanilla* species; flowers such as *Haplopappus*, *Alstroemerias* and *Hyphochaeris*, several cacti species and trees such as *Acacia caven*, *Quillaja saponaria*, *Maitenus boaria* or *Peumus boldus* (Hoffman 2015). All of these species are characteristics from this kind of ecosystem and therefore, floral resources are more abundant (Hoffman 2015). Other key resource is the potential host. Native bees of the family Megachilidae are abundant in this new record locality and could represent the principal prey of *M. metallica*. Nothing is known about the natural history or the potential host of *M. metallica* in the type locality. However, several bee species are present in this ecosystem and therefore, many potential host for the *M. metallica* (see for a complete review Montalva & Ruz 2010). Both areas are sensitive to human perturbation. In fact, several species, both Coastal Atacama Desert as well as Mediterranean ecosystem has been classified as threatened by local law (www.mma.gob.cl/clasificacionespecies). The fly was photographed on *Monttea chilensis* var. *taltalensis* Reiche, a plant catalogued as Endangered (EN) using the criteria of IUCN by Environmental Ministry of Chile (DS 51/2008 MINSEGPRES; www.mma.gob.cl/clasificacionespecies).

The presence of this rare species 1,352 km north of the type locality can be viewed in two ways. The record may serve to highlight the underestimation of the distribution of many species of insects, normally called Wallacean shortfall – a reference to the inadequate knowledge of any spatial scale distribution of organisms (Lomolino 2004; Cardoso *et al.* 2011). An alternative explanation is that the discovery in the Coastal Atacama Desert represents an undescribed species close to *M. metallica*. This exciting prospect can only be tested by obtaining specimens from this region and comparing them to the type of *M.*

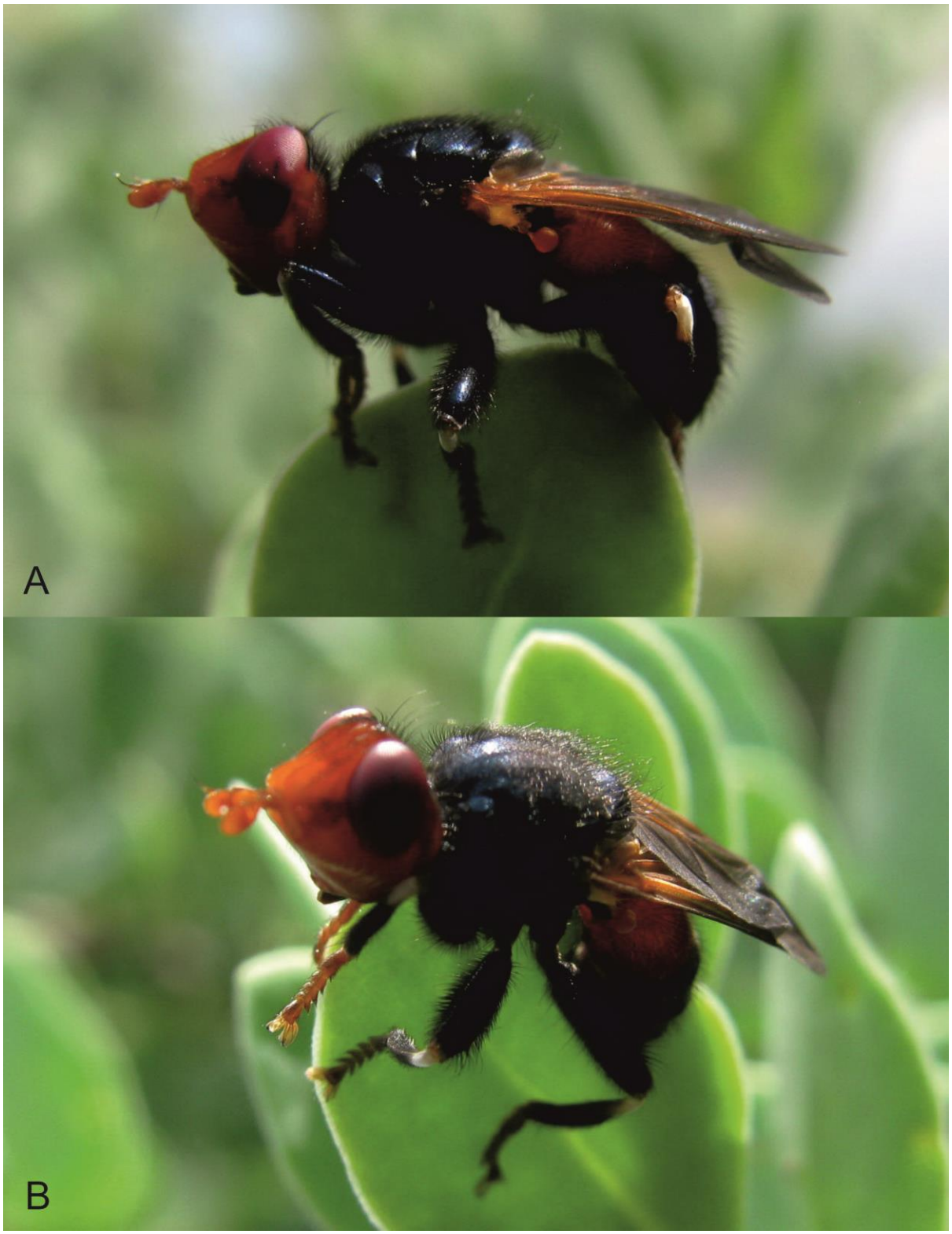

Figure 1. Living *Myopa metallica* Camras 1992. **A,** lateral view; **B,** front view. Both photos are the same individual and taken in north of Tal Tal in Atacama Desert. Photos by Maritza Zamora Gómez.

metallica. Further exploration of the type locality is also merited so that specimens from the two populations can be compared genetically. Is this a widespread generalist attacking

multiple hosts or is it a complex of two or more specialist species that may be extremely local and of significant conservation concern? Once the populations are genetically typified, next generation sequencing of potential bee hosts can quickly elaborate the specificity and distribution of the species.

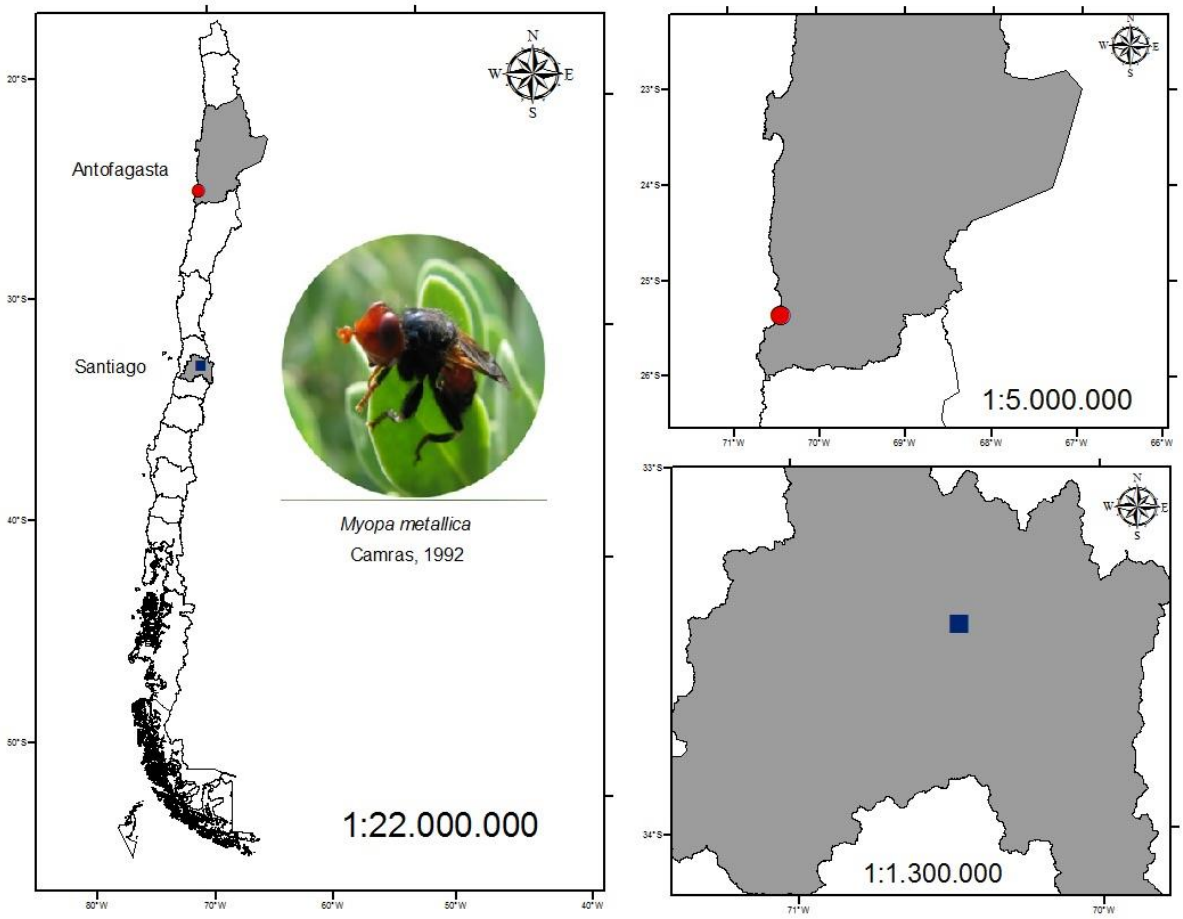

Figure 2. Distributional map of the *Myopa metallica*; blue square represent the individual of type locality; red circle represent the new locality registered on citizen science program.

The huge area where such conspicuous species are thought to be absent shows the importance of maintaining collections, and in parallel, involving volunteers to obtain photographic records. This photographic record was obtained from an ecological and cultural corporation called *Caminantes del Desierto,* members of which walk several unexplored areas of the coast and internal desert of the region of Antofagasta in the northern Chile. This demonstrates that naturalists and other social participants with minimal training can contribute to science with valuable information and focus on conservation biology (Miller 2005; Oberhauser & Prisby 2008; Oberhauser & Le Buhn 2012).

In a similar way, the citizen science project *Moscas Florícolas de Chile* used data to create a new understanding of the distribution of several species of poorly known flower flies, offsetting the Wallacean shortfall (Cardoso *et al.* 2011). Other citizen science projects perform similar functions such as mapping the flyways of monarch butterflies (Howard &

Davies 2009), developing feeding distribution models of mammals (Sequeira et al. 2014), and even informing policy when and where biological invasions are taking place, whether they be invasive plants or ladybugs (Gallo & Wait 2011; Roy & Brown 2015; Grez *et al.* 2016). Thus, citizen science and social networks can be an excellent opportunity for scientists to engage with non-specialists and conduct simple, large-scale projects. Valuable information can be obtained in this interaction between volunteers and scientists or parataxonomists (sensu Devictor *et al.* (2010)). Feedback generates more confidence from citizen volunteers and promotes further participation in a positive loop.

Myopa species may be vulnerable due to changes in host distribution and abundance, changes in land use, or the introduction of toxic chemicals into their environment. The potential disappearance of these flies may follow the decline of the native bumblebee *Bombus dahlbomii.* This bumblebee has been classified Endangered by IUCN and is thought to be threatened by invasive species and their parasites as well as the use of pesticides and habitat loss (Montalva 2012; Potts *et al.* 2016). More research is clearly needed about Chilean *Myopa* before we can assess their conservation needs. Perhaps in the future, we will know enough about *Myopa* and other fly species to be able to adequately assess them under IUCN criteria. In conclusion, citizen science using a social media can play a key role in unearthing new distributional records of rare species in groups of conspicuous flies.

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