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Male flowers in *Liliaceae* are more frequent than previously thought

Abstract

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In the last twenty years a growing number of studies emphasized the occurrence of female-sterile reproductive systems within the monocot order *Liliales*. The occurrence of male flowers is here documented for the first time in *Fritillaria involucreta*, *F. messanensis*, *F. montana*, *F. persica*, *Lilium bulbiferum* subsp. *croceum* and *Tulipa sylvestris*. Increasingly frequent observations of female-sterile systems within the order, and particularly in *Liliaceae*, suggest they could have an evolutionary significance.

Introduction

The adoption of sub-dioecious and sub-monoecious sexual models is rare among angiosperms (Charlesworth 2002). In particular, the female-sterile reproductive systems – andromonoecy and androdioecy – are considered the rarest strategies, being known for about 4,000 angiosperm species (Vallejo-Marin & Rausher 2007), which are approximately 1% of the total number. Despite the general rarity of female-sterile reproductive systems, even including particular cases such as gender diphasy, in the last twenty years a growing number of studies are emphasizing the occurrence of these strategies within the monocot order *Liliales*, where about 20% of the ca. 1,600 species are known to be dioecious (i.e. the whole family *Smilacaceae*, Kong & al. 2007; *Chamaelirium luteum* – *Melanthaceae*, Meagher & Thompson 1987; Smouse & Meagher 1994; Smouse & al. 1999), about 0.5% is known to show female-sterile systems (*Colchicaceae*: *Wurmbea dioica*, Barrett 1992; *Colchicum stevenii*, Dafni & Shmida 2002; *Melanthiaceae*: *Veratrum nigrum*, Liao & al. 2006; Liao & Zhang 2008; *Zigadenus paniculatus*, Emms 1993, 1996; *Liliaceae*: see over) and only 0.2% to show male-sterile systems (*Chionographis*, Maki 1992; Maki & Masuda 1993; Maki 1993). Accordingly, *Liliales* show an inverted proportion in occurrence of male-sterile and female-sterile systems, compared to other angiosperms, where gymonoecy/gynodioecy is 10-fold more frequent than andromonoecy/androdioecy (Delannay 1978; Jong & Klinkhamer 2005). Within *Liliaceae*, four species have been hitherto reported to be andromonoecious and/or androdioecious: *Gagea chlorantha* (Wolfe 1998), *G. graeca* (Peruzzi & al. 2008), *G. lutea* (Nishikawa 1998), *G. serotina* (Jones & Gliddon 1999; Manicacci & Desprès 2001), *Fritillaria camtschaticensis* (Matsuura 1935; Shimizu & al. 1998) and *F. persica* (Bambacioni 1928; Mancuso & Peruzzi 2010).

The occurrence of male flowers is here documented also in *Fritillaria involucreta* All., *F. messanensis* Raf. subsp. *messanensis*, *F. montana* Hoppe ex W. D. J. Koch, *Lilium bulbiferum* subsp. *croceum* (Chaix) Jan and *Tulipa sylvestris* L.

Material and Methods

Populations studied

Fritillaria involucreta – SE France, Maritime Alps, Caussols, April 2007

F. messanensis subsp. *messanensis* – S Italy, Calabria, Tarsia (Cosenza), April 2008

F. montana – N Italy, Tuscany, Piazza al Serchio (Lucca), April 2007

Lilium bulbiferum subsp. *croceum* – N Italy, Tuscany, Apuan Alps, Pian della Fioba (Massa), June 2008

Tulipa sylvestris – N Italy, Emilia-Romagna, Modena, April 2009

Sexual expression

The investigation of sexual expression modality was carried out for each flowering plant per population, taking note of the sex of all the flowers. They were considered hermaphrodite (H) when they had both well developed stamens and pistils and male (M) when they had only well developed stamens (Fig. 1).

Results

Each population studied revealed the presence of male flowers (Table 1). Males frequency ranged from a minimum of 10.94% in *Tulipa sylvestris* to a maximum of 37.86% in *Fritillaria montana*. The more frequent breeding system observed is androdioecy, also considering that most of the studied species bear usually 1 flower. Andromonoecy was also observed in *Fritillaria montana* and *Lilium bulbiferum* subsp. *croceum*.

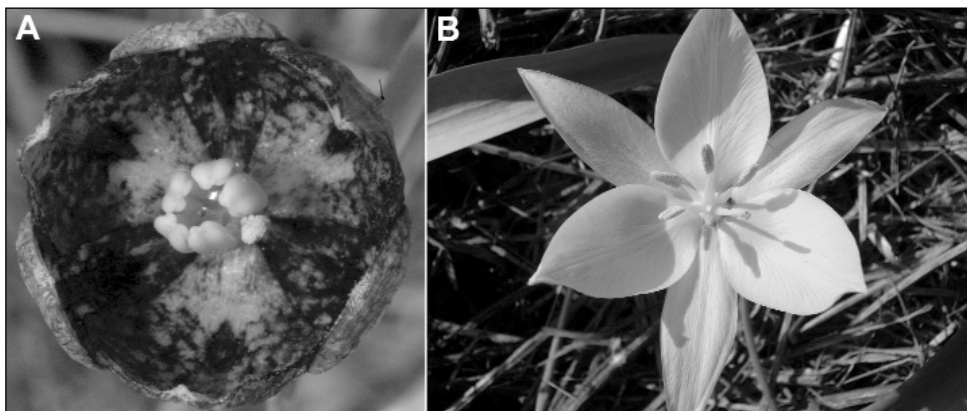


Fig. 1. Male flowers in *Fritillaria montana* (A) and *Tulipa sylvestris* (B).

Table 1. Sexual expression and population size in the 5 species studied.

	Pop. size	% male flowers	androdioecy	andromoeocy
<i>Fritillaria involucrata</i>	10	20	yes	no
<i>Fritillaria messanensis</i>	103	13.59	yes	no
<i>Fritillaria montana</i>	438	37.86	yes	yes
<i>Lilium bulbiferum</i>	12	33.33	yes	yes
<i>Tulipa sylvestris</i>	64	10.94	yes	no

Discussion

The present study documented for the first time the occurrence of female sterile systems in 5 *Liliaceae* species, raising to 0.9% the frequency of this phenomenon within *Liliales*. Increasingly frequent observations of female-sterile systems within the order, and particularly in *Liliaceae*, suggest they could have an evolutionary significance. Preliminary observations seem to indicate that in the studied species androdioecy (or, more rarely, andromoeocy) could be related actually with gender diphasy (i.e. smaller and/or younger plants are males) and with partial or total autoincompatibility (Mancuso & Peruzzi 2010).

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