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ex Webb (Campanulaceae) from the island of  
São Nicolau, Cabo Verde archipelago

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# Snails in the flowers of *Campanula jacobaea* C.Sm. ex Webb (Campanulaceae) from the island of São Nicolau, Cabo Verde archipelago

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## ABSTRACT

On the eastern flank of the island of São Nicolau in the Cape Verde archipelago, a species of snail *Leptaxis bollei* (Albers, 1854) (Pulmonata, Hygromiidae) was observed on several occasions in the flowers of *Campanula jacobaea* C.Sm. ex Webb (Campanulaceae), feeding on anthers and sheltering in the bottom of the corolla. Much more than just a predator, the snail is an occasional but active transporter of pollen on its shell, favouring cross-pollination and considered here a rare example of malacophily.

## KEY WORDS

Pollinisation,  
Mollusca,  
Campanulaceae,  
Cabo Verde,  
malacophily.

## RÉSUMÉ

*Des escargots dans les fleurs de Campanula jacobaea C.Sm. ex Webb (Campanulaceae) de l'île São Nicolau, archipel du Cap Vert.*

Dans la partie orientale de l'île São Nicolau dans l'archipel du Cap Vert, une espèce d'escargot, *Leptaxis bollei* (Albers, 1854) (Pulmonata, Hygromiidae), a été observée à plusieurs reprises dans des fleurs de *Campanula jacobaea* C.Sm. ex Webb (Campanulaceae), dévorant les anthères et s'abritant dans le fond de la corolle. Bien plus qu'un prédateur, cet escargot participe occasionnellement, mais activement, au transport de pollen sur sa coquille, favorisant alors la pollinisation croisée et ainsi considéré ici comme un des rares cas de malacophilie.

## MOTS CLÉS

Pollinisation,  
Mollusques,  
Campanulaceae,  
Cap Vert,  
malacophilie.

During several plant-collecting expeditions on the island of São Nicolau in Cabo Verde archipelago, between 2014 and 2017, snails were observed feeding on anthers and sheltering in the corollas of several populations of *Campanula jacobaea* C.Sm. ex Webb (Campanulaceae), a bellflower endemic of the mountainous western islands of the archipelago (Leyens & Lobin 1995; Gardère 2015). With light brown shells and measuring between (0,5-)0,7-1,2(-1,5) cm in diameter, the snails all belong to a single species, *Leptaxis bollei* (Albers, 1854), (Pulmonata, Hygromiidae), endemic to the archipelago (Rólan 2005). The observations were made November 20<sup>th</sup>, 2014; from December 14<sup>th</sup> to 16<sup>th</sup>, 2015; and from December 12<sup>th</sup> to 14<sup>th</sup>, 2017. Except the rainy season (July-September), the period from November to February is humid, with high atmospheric nebulosity (Olivry 1989) and coincides with the blooming of many endemic plants.

The observations were made in several localities on the edges of the tops of cliffs along the ridges of Alto das Cabaças, an isolated region in the eastern part of the island of São Nicolau. Facing north and exposed to the trade winds, this high rugged area (c. 650m a.s.l.) harbours *C. jacobaea* that belongs to a rupicolous vegetation composed of micro-endemic frutescent species such as *Conyza schlechtendalii* Bolle (Asteraceae), *Helichrysum nicolai* N. Kilian, Galbany & Oberpr. (Asteraceae), *Diploptaxis sundingii* Rustan (Brassicaceae), *Limonium sundingii* Leyens, Lobin, N. Kilian & Erben (Plumbaginaceae) in association with widespread Cabo Verdean endemic species like *Sonchus daltonii* Webb (Asteraceae), *Launaea procrudifolia* (Webb) Engl. (Asteraceae), *Aeonium gorgoneum* J.A. Schmidt (Crassulaceae), *Lotus purpureus* Webb (Fabaceae), *Verbascum capitis-viridis* Hub.-Mor. (Scrophulariaceae), a few *Euphorbia tuckeyana* Webb (Euphorbiaceae) and with indigenous herbaceous plants, *Oxalis corniculata* L. (Oxalidaceae) and *Arthraxon lancifolius* (Trin.) Hochst. (Poaceae). Numerous bryophytes and lichens are also present, as well as two ferns, *Adiantum capillus-veneris* L. (Pteridaceae) and *Asplenium hemionitis* L. (Aspleniaceae) whose fronds are also eaten by the snail.

The summits of Alto das Cabaças are regularly covered in fog (Cunha 1964). Water vapour condensing on vegetation creates occult precipitation, a meteorological phenomenon essential for the snail. Otherwise, it is important to highlight that the bellflowers of Alto das Cabaças are notably floriferous over the course of observational period, and grow as branched prostrate subshrubs. This habit is advantageous for the snails that can thus easily access the leaves and the flowers, the most impressive of the plant community. These flowers have a characteristic bell-shaped corolla measuring 1.8-2.2 cm at the opening and 0.8-1.2 cm mid-length; their anthesis lasts 4 to 5 days. Individual plants grow in isolation or often in close clumps, to the point that their flower stalks are intertwined.

As with most of the Campanulaceae, the flowers of *C. jacobaea* are protandrous (Leins & Erbar 2006). The male phase of anthesis begins in the unopened bud, the dehiscent anthers deposit the pollen on the stylar hairs along the

immature style and on the dorsal side of the still closed stigmatic lobes. On blossoming, the secondary pollen presentation is initiated through the growth of this 'stylar brush' that will bring the pollen closer to the lobes of the corolla. This mechanism enables easier transfer of the pollen from the flower to potential visitors. Next, the stylar hairs retract into their own bulbous base and the stamens curl away. The flower then enters the female phase of anthesis with the opening of its stigmatic lobes.

*L. bollei* creeps into the corolla (Fig. 1A) to feed on the anthers and filaments (Fig. 1B), while generally sparing the style and the nectary disk, although the base of the corolla is sometimes nibbled (Fig. 1C), then it changes flowers. Up to three snails were observed in a single flower and up to 12 were present in a small group of c. 20 flowering plants. When the snail goes into a flower in the male phase of anthesis, pollen is deposited on its shell when it rubs against the stigma (Fig. 1D). Afterwards, when the next flower it visits is in the female phase of anthesis, its shell will redeposit pollen on the stigmatic lobes.

As soon as the ambient humidity is no longer suitable for its activity, the snail will withdraw to the depths of cracks in the rocks or under the leaves of the bellflowers. Oftentimes it will also hide in the flower, lodging its shell against the corolla or nectary disk. In doing so, it blocks the only observed flying pollinator, *Amegilla godofredi* Sichel *in* Dours (Hymenoptera, Apidae), from gathering nectar (J. Straka pers. comm.). The pollinators, or at the very least the visitors, of Cabo Verdean bellflowers are poorly known and few observations have been made on their subject. Leyens & Lobin (1995) suggested, although without having made direct observations, that the flowers of *C. jacobaea* could be pollinated by *Xylocopa modesta* F. Smith, (Hymenoptera, Anthophoridae), whereas Olesen *et al.* (2012) recorded the visit of small solitary bees (Hymenoptera, Halictidae) in just two populations.

Very few shepherds venture into this high altitude, rough and isolated area of São Nicolau but some know of the presence of snails in the blue flowers that they regularly come across on the summits of the mountain and call it "flor de caracol" (Snail-Flower) (Lopes Araújo pers. comm.).

Pollinisation by snails or slugs, called malacophily is a rare phenomenon, qualified by some authors as "notorious and obscure" (Faegri & Pijl 1979) or even "ridiculous" (Atwood 1982). However, this type of pollinisation appears closely linked to the circumstances of predation and particularly to the feeding on the anthers (palynophagy) or perianth (anthophagy). Some cases of palynophagy and/or anthophagy by snails or slugs have been signalled (Delpino 1869; Wilson 1889; Lorougnon 1973; Neijzing & Zeven 1976; Olesen 1979; Derooin 2000) and some authors have clearly shown that such behaviour leads to malacophily (Delpino 1869; Wilson 1889; Pammel & King 1930; Lorougnon 1973; Sarma *et al.* 2007; Raju *et al.* 2014). According to Pammel & King (1930), malacophilous plants must have certain characteristics to enable this type of pollination: a prostrate growth type, easily



FIG. 1. — Behaviour of *Leptaxis bollei* (Albers, 1854) on the flowers of *Campanula jacobaea* C.Sm. ex Webb: **A**, snail creeping into a flower; **B**, snail eating the stamens during the female phase of anthesis; **C**, base of corolla slightly nibbled by a snail; **D**, snail rubbing its shell loaded of pollen grains against the stigma (female phase of anthesis).

accessible flowers with floral structure where anthers and stigmas are contained within the corolla; and a longer period of flowering than that of entomophilous species. All of these conditions are respected in the case of these Cabo Verdean bellflowers. *Leptaxis bollei* is thus considered here an active occasional, but not exclusive, cross-pollinator of *C. jacobaea*, because it transports (albeit slowly) pollen between the flowers of a same (geitonogamy) or different individual plants (xenogamy).

#### MATERIAL EXAMINED

The studied material is deposited in the Muséum national d'Histoire naturelle (MNHN) in the herbarium (P) and in the molluscs collection (MNHN-IM).

#### *Campanula jacobaea*

Cabo Verde. Alto das Cabaças, végétation rupicole au bord des falaises sommitales, c. 650 m., 14.XII.2015, *M. Gardère* 1119 and 1120 (P[P02091099, P02091100]).

*Leptaxis bollei*

**Cabo Verde.** Alto das Cabaças, escargots collectés sur un spécimen de *C. jacobaea* mis en herbier (*M. Gardère 1120*), c. 650 m., 14.XII.2015, *M. Gardère s.n.* (MNHN-IM-2013-49578).

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