Notes on the phenology of Dittrichia viscosa

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Abstract

Dittrichia viscosa L. (W. Greuther) (Asteraceae) (synonym *Inula viscosa*) is a common ruderal plant occurring in the Mediterranean region. It is important as natural food source for caterpillars of butterflies and moths and can be employed in biological control as resource for predatory insects. Furthermore, it is a weed in some countries, e.g. in Australia. Despite its wide distribution, its use and common employment, and its threat as invasive plant, little knowledge has been scientifically assessed about this species. In this note we present a descriptive study of the phenology of *D. viscosa* in Southern France. *D. viscosa* with its nectar and pollen resources delivered in late summer and autumn attracts and maintains populations of arthropods, some of which may be beneficial arthropods employed in biological pest control. Knowledge about the phenological cycles of this plant species therefore is of fundamental value.

Introduction

Dittrichia viscosa L. (W. Greuther) (Asteraceae; Figure 1) is a herbaceous perennial plant of the Mediterranean region. It occurs from southern Europe (France, Spain, Greece, Italy, Bulgaria) and Turkey, to the Middle East (Israel, Jordan and Syria) and northern Africa (Algeria, Egypt, Libya) (USDA GRIN 2012) in the coastal range of the Mediterranean Sea without a clear microhabitat restriction. It is typical for ruderal environments (Figure 2) and is an important natural food source for caterpillars of butterflies and moths (Alomar et al., 2002, Perdikis et al., 2007, 2008, Parolin et al. 2014a). Due to its chemical compounds it is employed for a wide range of traditional uses, e.g. it is used for phytoremediation in contaminated soils serving as 'phytoextractor' (Barbafieri et al., 2011, Conesa et al., 2011, Jimenez et al., 2011), 'bioaccumulator' (Murciego et al., 2007) on contaminated soils, or as 'bioindicator' (Ater et al., 2000), especially since the species is not only tolerant to high concentrations of trace elements but also adapted to the specific ecological and climatic conditions of the area (Bidar et al., 2007). D. viscosa could act as 'phytostabilizer' in highly contaminated soils where no other plants can grow (Conesa et al., 2011, Jimenez et al., 2011, Nogales and Benitez 2006). Due its allelopathic characteristics, exudates of D. viscosa have a potent herbicidal activity which can be incorporated in weed management as source of natural herbicides (Omezzine et al., 2011a, b). The allelopathic potential is attributed mainly to leaf leachate, which indicates the facility of providing

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this product and its use in irrigation (Omezzine et al., 2011a). The extracts made from leaves possess broadspectrum activity against foliar diseases of crop plants (Wang et al., 2004). They are useful in disease control which may be significant to the agricultural industry when fungal strains resistant to site-specific fungicides prevail, as well as to organic farming where synthetic pesticides are prohibited (Wang et al., 2004). Its role for biological control as major source of the polyphagous predator *Macrolophus caliginosus* and as winter refuge for this and other species of predators was documented (Alomar et al., 2002, Perdikis et al., 2007). *D. viscosa* may act as insectary plant (Bas et al., 2003), i.e. a flowering plant which attracts and possibly maintains, with its nectar and pollen resources, a population of beneficial arthropods which are employed in biological



Figure 1: *Dittrichia viscosa* – A) whole flowering plant (August), B) flower detail, C) mature fruits, D) mature adult plants in the background and young non-flowering plants in the foreground (October), E) new leaves on old twigs in spring (April)



Figure 2: Young plant of *D. viscosa* growing along roadside.

pest control. Therefore knowledge about the phenology of this plant species is of fundamental value.

In the present paper we describe the phenological development of two stands of *D. viscosa* in Southern France which we monitored throughout a year, and point out the importance of these cycles for associated insects such as beneficial arthropods which can be employed for biological pest control (Broumas et al., 2002; Franco-Micán et al., 2010; Petacchi et al., 2003; Warlop et al., 2010).

Methods

We monitored *D. viscosa* on two sites in Southern France in Biot St. Philippe from January 2012 to November 2013. Both sites are completely exposed to the sunlight near roads on abandoned land, at about 2 km distance from each other (Figure 3A: N 43°37'21.9" E 7°4'20.5" at 106 m asl; Figure 3B: N 43°37'1.7" E 7°4'35.0" at 123 m asl). Only adult healthy plants were chosen which were not artificially cut. We chose the plants to be marked by random.

We marked ten adult plants on each site. We took annotations of their phenological condition at intervals of 1-2 weeks, including presence of new/adult/senescent leaves, leaf size, presence of flower buds or mature flowers, presence of fruits, fruit maturation. For data presentation we joined the data to a monthly mean.

Results

We did not find significant differences between the plants on the two adjacent sites, and also within a site the phenological development was homogeneous among the ten marked plants. The main phenological events are marked in Figure 4 together with the mean monthly temperature and precipitation.

Leaf phenology

D. viscosa started to produce new leaves at the end of March (Northern hemisphere early spring, Figure 1E). The new leaves were positioned at the lower stem bases which were left with old dry leaves from the previous year. New leaves were maximum 1cm long, on the lower third of the stems on the 1st of March in



Figure 3: Two sample sites for phenological recordings of *Dittrichia viscosa* in Biot St. Philippe, France. Coordinates of the sites A) N 43°37'21.9" E 7°4'20.5", B) N 43°37'1.7" E 7°4'35.0".



Figure 4: Mean temperature (°C) and precipitation (mm rainfall) in Biot St. Philippe, Southern France, and timing of phenological events.

all monitored plants. By April, the new leaves were 1-5cm long, still on the lower third of all stems and on some tips. By mid April the leaves expanded to 3 cm width, and by the end of April new leaves were 8-10 cm long and covered densely the lower half of all stems and some of the tips. The monitored adult plants were covered by leaves by 30 %. In mid May the new leaves were about 8-10 cm long and some had reached their full expansion. An estimated 60-90% of the stems were covered by new leaves. At the end of May all plants were covered to 80-90% by new leaves, with many fully expanded leaves and still producing new ones. Thereafter, in the Northern hemisphere summer and early autumn, new leaves were continuously produced by the plants and until the end of October many big healthy fully expanded green leaves were present.

From November on (Northern hemisphere winter), only few leaves were green and most of the plants turned to a greyish colour due to strong leaf senescence (Figure 3). By mid November, only 5% of the leaves on the plants were green, the rest was dry and supposedly dead. This condition was maintained throughout the whole winter, until in late March (Northern hemisphere spring) new leaves were sprouted.

Flowering phenology

Flower buds started to be present in late July (Northern hemisphere summer). From the 10th of August on, most flowers were mature, bright yellow and wide open. New flowers were produced until mid October. In the beginning of November (Northern hemisphere winter) few new yellow flowers and some green leaves were still present, but most of the plants was dark yellow / brownish to grey as the leaves and flowers started to get senescent.

Fruiting phenology

On October 5, we observed the first mature fruits with achenes and a hairy pappus. Mature fruits were

constantly present until the beginning of November (Northern hemisphere winter). Then, the wind dispersed seeds were all gone and the fruits were empty, but the dry capsules remained on the stems throughout the winter (Figure 1E). We did not monitor the presence of galls on the chosen plants, but there were a few on the plants on the study site B, and several in non-distant populations, clearly visible on the mutated flowers which did not develop to fruits (Figure 6).

Discussion

The study plants performed a typical phenological pattern for the species, with a main growth period and starch accumulation completed by May to June, and leaf loss by December (Meletiou-Christou et al., 1998, Scott et al., 2008). However, the climate of the recording period was partly unusually cold and wet (spring 2013), and plant development overall may have been delayed by a few weeks. However, our recordings had an overlap of several months and differed only to a little extent between 2012 and 2013. Furthermore, the timing of phenological events of *D. viscosa* found in Southern France (Figure 4) did not differ significantly from that of *D. viscosa* in other Mediterranean countries.

In Israel, one of the most southern latitudes of its natural habitat range (http://www.inulav.com/Inula_ Viscosa.html), the onset of flowering is earlier, starting in June. However, within one population the onset of flowering may differ by 15-20 days (www.sardegnadigitallibrary.it/documenti/17_81_20080411103206. pdf) in this species.

Some studies report the species as evergreen (e.g. Perez-Latorre & Cabezudo 2002). As we could observe in *D. viscosa* growing in experimental fields close to the study sites, only if *D. viscosa* is cut it is evergreen (FEDER 1997). If it is cut in summer, flowering does not take place and green leaves are maintained throughout the winter time (Figure 5). If it is not cut, it produces a high amount of flowers, and in autumn it has highly senescent leaves are present on these, contrary to the plants which did not flower.

The leaves and stems of the plant are coated with a sticky resin (Wang et al., 2004; Omezzine et al., 2011a, b) which is present as soon as the leaves expand but is particularly concentrated from September through the winter months. Old leaves lose their capacity of exudation of essential oils and the deciduous plants with grey leaves do not smell as strong as those which maintain green leaves.

The importance of maintaining green leaves for the populations of insects which colonize these plants has not been analyzed. We assume that the evergreen plants may play an important role here. The yellow hermaphroditic flowers are insect pollinated and pro-



Figure 5: Plants of *D. viscosa* which are several years old, in January (Northern hemisphere winter): in the background plants were not cut, they flowered and have no green leaves (deciduous); in the foreground the plants were cut in summer, did not flower and maintain their green leaves throughout the winter.

vide one of the few food sources available to honey bees during autumn as flowers are present until November. The flowering period of most Mediterranean plant species is concentrated in April and May (Pico & Retana 2001), but D. viscosa has its flowering peak in late summer and autumn, and the duration of flowering is very long. Therefore, D. viscosa can be considered as important entomophilous species which hosts arthropods in otherwise hostile conditions. In general, flowering time has a large impact on herbivory and disease, and extended flowering might act as a mechanism to compensate for reproductive failure in some parts of the season (Pico & Retana 2001). Whether this is the case for D. viscosa and which selective forces determine extended flowering cannot be stated with the present data.

D. viscosa is important for certain beneficial arthropods which help to control common pests in the Mediterranean basin (Franco-Micán et al., 2010; Warlop et al., 2010). The flowers of *D. viscosa* are often infested by *Myopites stylata* Fabricius, a dipteran which causes gall formation (Neuenschwander et al., 1983; Figure 6) and whose larvae are parasitized by the generalist parasitoid *Eupelmus urozonus* which also feeds on the olive fly and thus helps to protect olive production (Boccaccio and Petacchi, 2009; Broumas et al., 2002; Franco-Micán et al., 2010; ITAB, 2005; Petacchi et al., 2003; Warlop et al., 2010). The interactions between pests and predators are closely linked to the presence

of *D. viscosa*, to the timing and duration of flowering and the possibility to form galls on the plant. The larvae of *M. stylata* overwinter on *D. viscosa*.

We recommend the use of *D. viscosa* as secondary plant (Parolin et al., 2012), e.g. for biological control of the olive fly, but only for its native range, the Mediterranean basin. It has a high potential as biocontrol plant (Parolin et al. 2014b), i.e. to enhance crop productivity by pest attraction and/or pest regulation and thus contributing to increasing biocontrol services. However, it may also enhance the presence and proliferation of undesired pest organisms as was shown in a study implying *D. viscosa* and whiteflies *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae) (Parolin et al. in press).

Due to its potential invasive character (DPIPWE, 2011; Sinden et al., 2004; Bresch et al. in press) it should not be planted on other continents. Furthermore, we need more scientific evidences for differences in timing and triggers for phenological cycles. So far, we do not understand the importance of soil quality, water availability, or climate on the development and phenological performance of this species. This hinders its practical employment in biological control programs, which so far rely on single observations and few publications.



Figure 6: Galls formed in flowers of *D. viscosa* caused by the dipteran *Myopites stylata*.

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