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Germination ecology of wild living walls for sustainable vertical garden in urban environment

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ABSTRACT

Germination characteristics of 10 xerophytic species, widespread in the Mediterranean were studied. A variety of seed treatments were explored to overcome the seed dormancy, including scarification and stratification. Only in *Convolvulus cantabrica* dormancy was shown to be physical, since it could be removed by seed coat scarification. Several species showed light-dependent germination, possibly related to the fact that in their micro-environment of incubation they are exposed to minimum seed burial. Emergence tests in peat-perlite substrate were carried out in order to verify the optimal burial conditions for seed propagation. This inhibition was found to be inversely related to the low unit weight of seed. Species with minute seeds, such as *Erigeron karviskianus* and *Phagnalon rupestris,* had the best performance of germination without burial, while the larger ones such as *C.cantabrica* and *Centranthus ruber,* had the best performance at 6 and 4 mm of sowing, respectively.

1. Introduction

Green spaces in landscape can enhance urban living and offer benefits such as psychological recreation and environmental improvement (Ulrich, 1979) especially in terms of noise reduction (Smardon, 1988). Urban vegetation is essential for creating wildlife habitat, which is linked to biodiversity in man-made ecosystems (Burgess et al., 1988). Although in cities space is limited at ground level, vertically it is not, hence there exists a possibility of "greening" urban walls. This vertical vegetation, which has been referred as "vertical gardens" (Solecki and Welch, 1995), "living walls" (Dunnett and Kingsbury, 2004) or "green walls" (Viles and Wood, 2007) has high aesthetic impact and value (Gobster, 1998). Such micro-ecosystem (Perini et al., 2013) has shown reduction of "heat island effect" (Gill et al., 2007), linked to its evaporative cooling (Davis and Hirmer, 2015). One of the benefits of living walls has been their capacity to provide clean air into the building on which they are growing (Bolund and Hunhammar, 1999). However, due to the live nature of the walls, some economic and ecological questions arise, as plants need water to survive and grow. The use of any cultivated plant in an urban environment necessitates sustained input of water and hence questions their ecological sustainability (Brandes, 1995). In contrast, wild xerophytic vegetation (native and/or naturalized) is able to grow without irrigation (Benvenuti and Bacci, 2010) and this reduced water requirements is important in view of future climatic scenarios (Le Hoùerou, 1996).

In contrast, old buildings are often colonized by a certain type of vegetation which is able to survive and grow in such disturbed ecological niche without human intervention (Hruška, 1987; Caneva et al., 1992; Lisci and Pacini, 1993; Lisci 1997) not only in Mediterranean environment but even in other climatic conditions (Rishbeth, 1948; Reis et al., 2006). An example of this 'neglected' biodiversity has been found in the Colosseum in Rome where more than 680 species have been recorded (Caneva et al., 2003). A survey of flora growing on ancient Byzantine walls in Thessaloniki (Greece) showed the presence of 420 different *taxa* (Krigas et al., 1999). Such rich biodiversity has been attributed to their ability to survive in stressful ecological conditions and to their dispersal strategies (Benvenuti, 2004). The ecological stress is not only due to scarcity of nutrients, but also to overall erratic water availability that typically distinguishes walls of urban ecosystems.

Even if this naturalized flora did not evolve in the urban ecosystem, it was able to spread due to its remarkable ability to colonize new areas, both in terms of survival and seeds dispersal (Benvenuti, 2004). Its origin can be traced to rocky outcrops in neighbouring ecosystems and in urban areas similar to their endemic sites (Láníková and Lososová, 2009; Ceschin et al., 2014). Ironically, due to the loss of natural habitats such man-made environments have become important for biodiversity protection (Francis, 2010).

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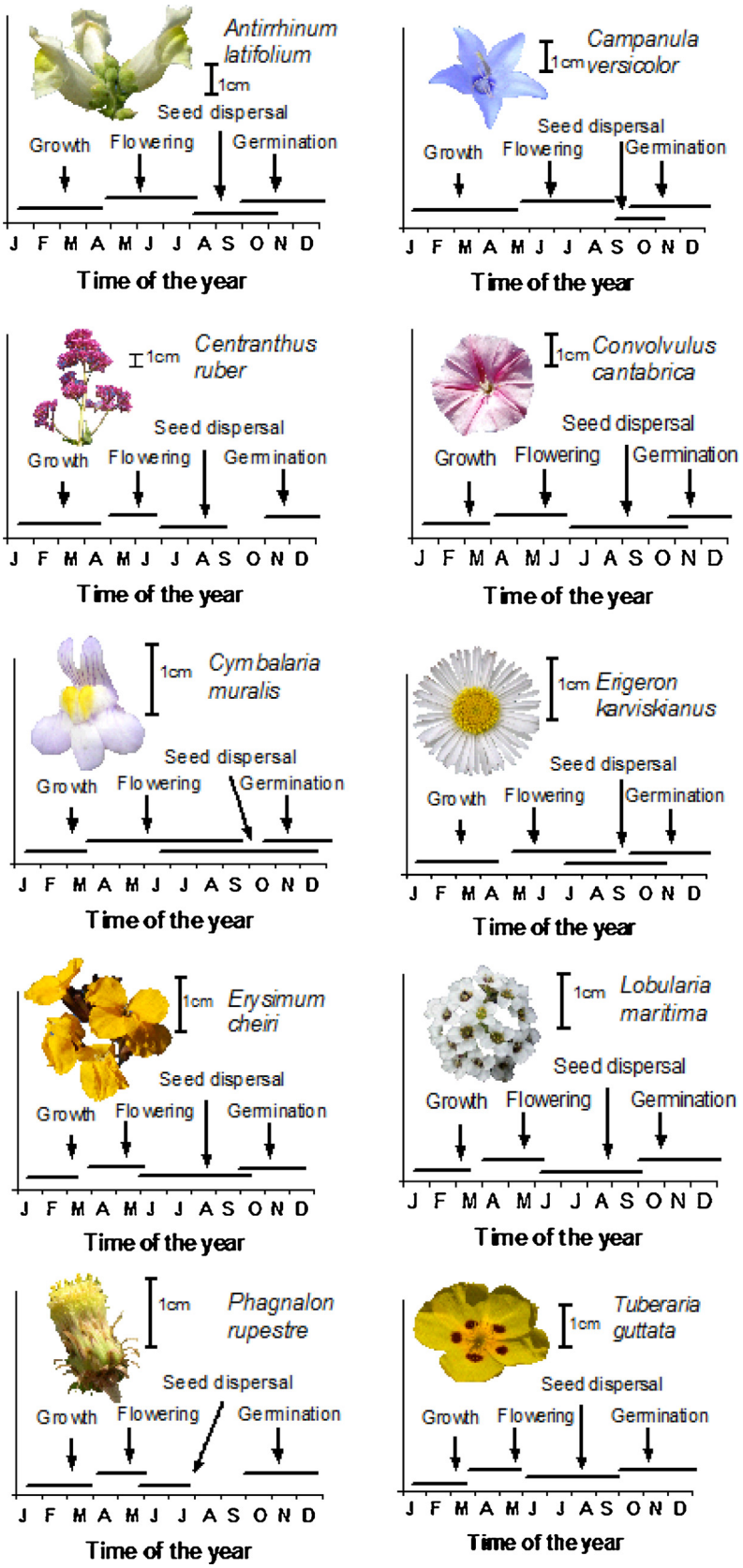

Fig. 1. Schematic representations of phenological stages of ten wall flora species. Information on phenology was obtained through visual observations carried out in Tuscany (Italy) environment. X-axis equals one year with months shown as abbreviated letters. The respective flower morphologies are shown with 1 cm scale for reference.