



Ecological generalization and conservation of ornamental *Salvia*

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Salvia is a species-rich genus with a high level of diversity, with approximately 1,000 species distributed worldwide in a variety of habitats, and distinctive pollination modes (Fig.1; Kriebel et al., 2019; Xiao et al., 2022a). China is one of the three diversity centers with 82 species (Fig.2) . *Salvia* is widely used in ornamental, culinary, and/ or medicinal fields due to its various plant types, flower types, flower colors, and its richness in many aromatic substances and medicinal ingredients (Fig.3). It is also known for its staminal lever mechanism.

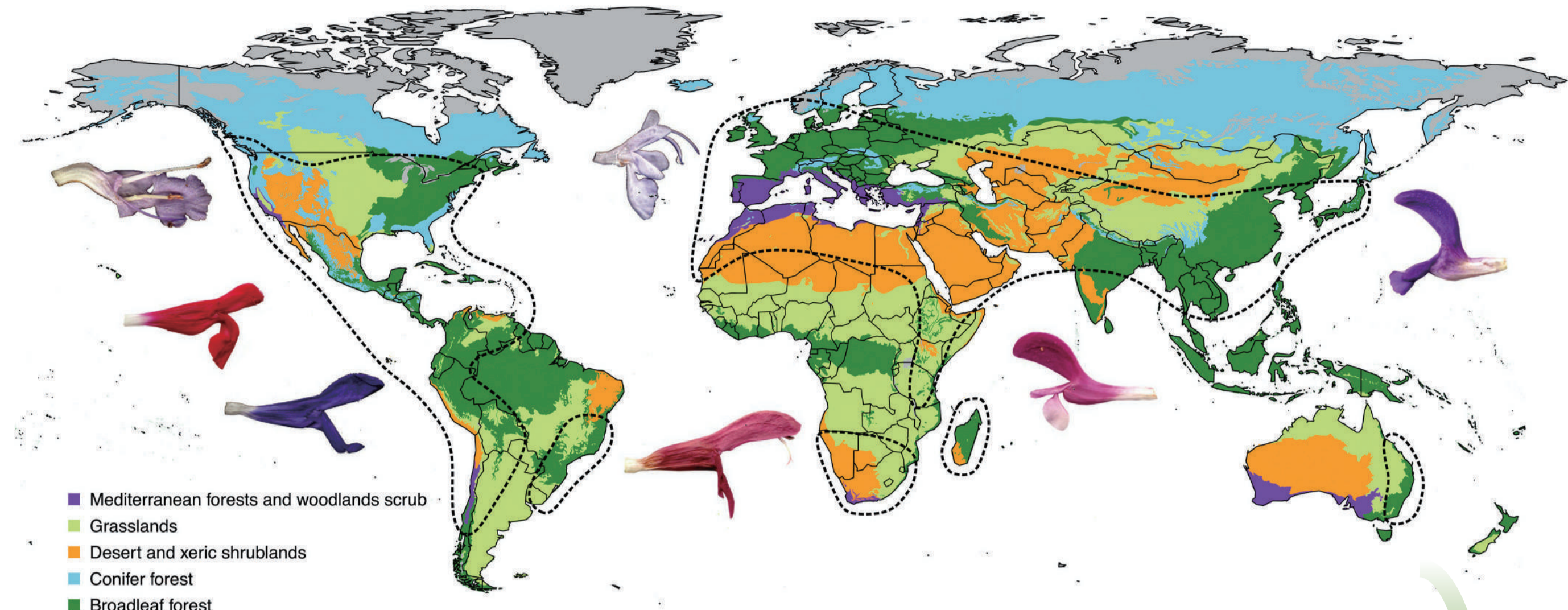


Fig. 1 World distribution and biome types of *Salvia* (Kriebel et al., 2019)

■ Subgen. *Allagospadonopsis*
■ Subgen. *Salvia*
■ Subgen. *Sclarea*

Fig. 2 Distribution and diversity of *Salvia* in China

Fig. 3 Diversity of flower types and colors in *Salvia*

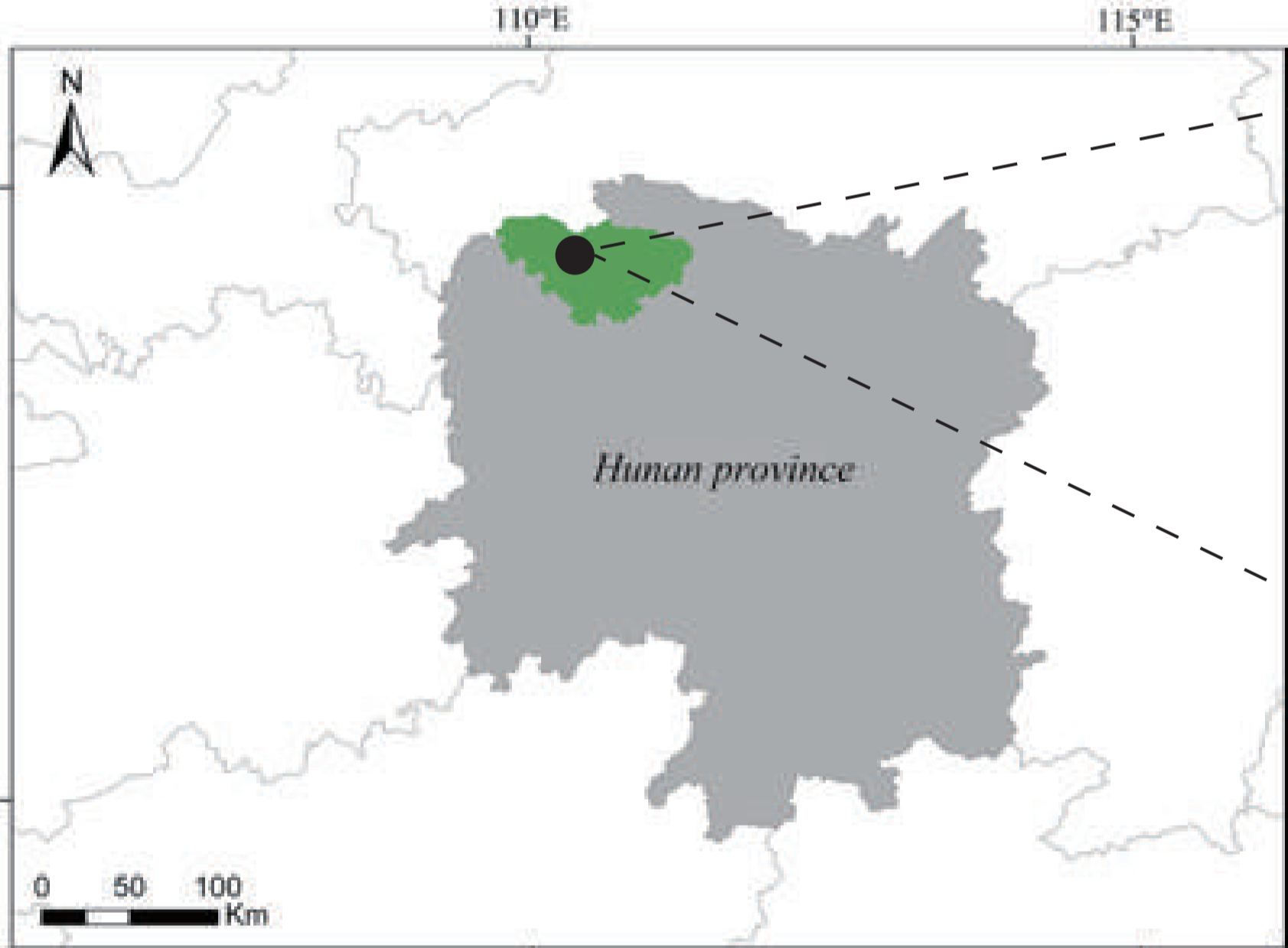


Fig. 4 Distribution, habitat, and inflorescence of *Salvia daiguii*

Salvia daiguii is a recently described new species of *Salvia* only native to the Tianmenshan National Forest Park. It grows mainly on or under cliffs and on rocks in a streambed (Fig.4). Our physiological tests indicate that *S. daiguii* is tolerant to varying degrees of stress such as high temperature, high humidity, drought, salinity, and acid rain. Also, it has a high medicinal and ornamental value. However, because of its narrow geographical distribution, the species is potentially facing a high risk of extinction and conservation action is therefore required.

Table 1 Frequency of visits by bees and hawkmoths on *Salvia daiguii*

	<i>Apis cerana</i>	<i>Macroglossum bombylans</i>	<i>p</i> -value
Total number of flower visits during the 3 days of video documentation	3052	505	/
Total number of flower visits per day	508.67 ± 159.47 (<i>n</i> = 6)	84.17 ± 19.42 (<i>n</i> = 6)	<0.001
Average number of flowers visited per plant	9.57 ± 0.50 (<i>n</i> = 319)	15.30 ± 2.28 (<i>n</i> = 33)	0.007
Duration of single flower visits (s)	4.08 ± 0.17 (<i>n</i> = 3052)	0.58 ± 0.02 (<i>n</i> = 505)	<0.001
No. of visits per flower per day	6.48 ± 1.68 (<i>n</i> = 6)	1.16 ± 0.13 (<i>n</i> = 6)	0.009
No. of pollen grains deposited after a single visit	4.74 ± 1.01 (<i>n</i> = 20)	1.38 ± 0.32 (<i>n</i> = 16)	0.002

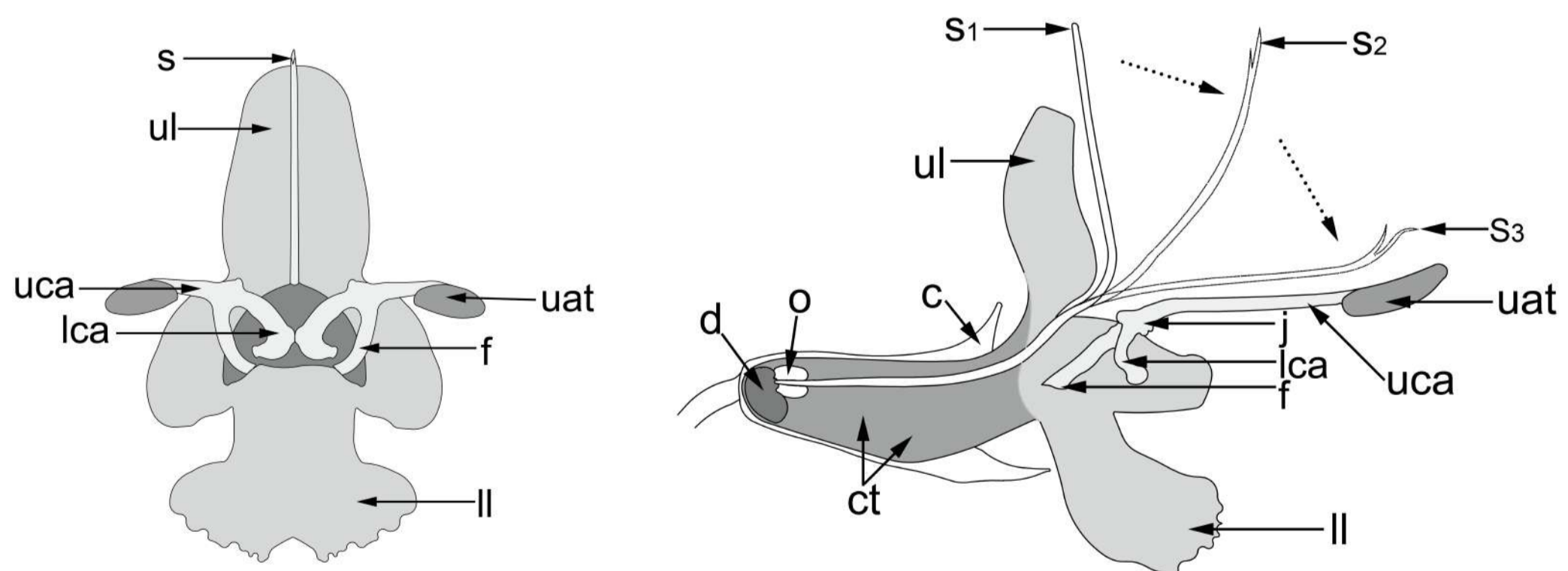


Fig. 5 Flower structure and flowering process of *Salvia daiguii*



Fig. 6 successful ex situ and in situ conservation of *Salvia daiguii*

At present, we found that the primarily bee-pollinated *S. daiguii* bend their style allows a nectar thief to become a secondary pollinator without affecting the fundamental phenotype (Fig. 5; Table 1; Xiao et al., 2022b). Recently, we have successfully ex situ conservation it in the Botanical Garden (Xiao et al., 2022c). Then, propagated individuals were reintroduced into wild areas near the species' original habitat (Fig. 6). To provide information for the recovery of the wild population, we are conducting a comprehensive study of the species population ecology, seed physiological ecology, metabolomics, genetics and artificial hybridization.

[1] Xiao HW, et al. (2022a). Diversity of visiting insects and changes of pollinator behavior in alpine species *Salvia castanea*. Acta Ecologica Sinica, 42(5): 1841-1853.

[2] Kriebel R, et al. (2019). Tracking temporal shifts in area, biomes, and pollinators in the radiation of *Salvia* (sages) across continents: leveraging anchored hybrid enrichment and targeted sequence data. American Journal of Botany, 106(4): 573-597.

[3] Xiao HW, et al. (2022b). Effective hawkmoth pollination in the primarily bee-pollinated *Salvia daiguii*—an example of adaptive generalization. Plant Species Biology, 1–9.

[4] Xiao HW, et al. (2022c). Successful ex situ conservation of *Salvia daiguii*. Oryx, 56(5), 650-651.