INVASIVE PLANT SPECIES THROUGH THE BEE EYE: AN ANALYSIS OF FLOWER COLORATION IN THE FRENCH PYRENEES

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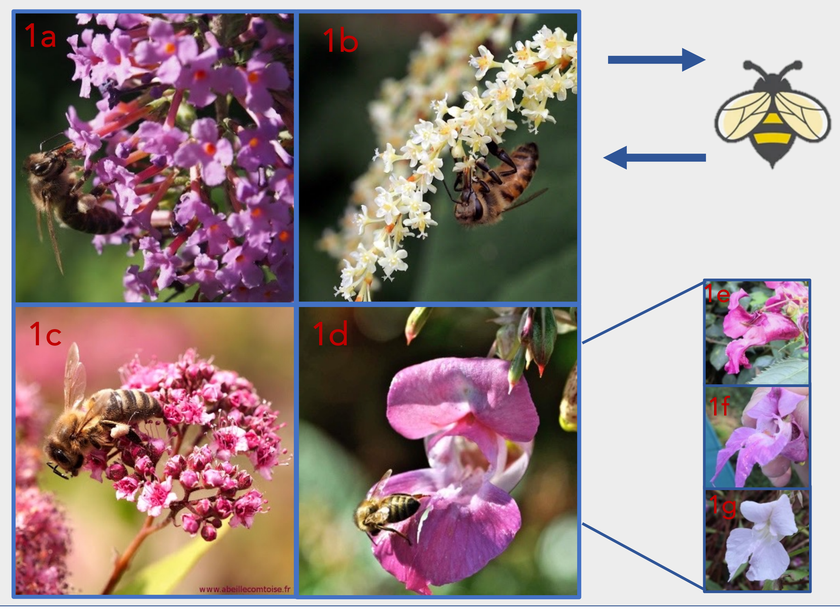
1. Introduction



In the Pyrenees, invasive flower species may constitute a **threat** for native species while providing potential **new resources** for pollinators. Here we focused on **flower color advertisement** to determine if invasive species have **an increased perceptual salience for bee pollinators with respect to native species, thus potentially enhancing their own reproduction dispersal**.

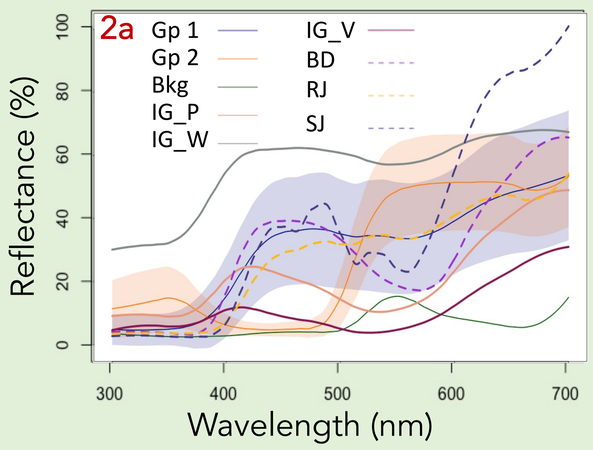
Using a UV-sensitive **spectrophotometer**, we measured the **reflectance** of 71 floral species, including **4 invasives floral species:** *Buddleja davidii* (**BD**, Fig. 1a), *Reynoutria japonica* (**RJ**, Fig. 1b), *Spiraea japonica* (**SJ**, Fig. 1c) and *Impatiens glandulifera* (Fig. 1d) with its three morphs : human violet (**IG_V**, Fig. 1e), human pink (**IG_P**, Fig. 1f) and human white (**IG_W**, Fig. 1g).

Focusing on **honey bees**, a representative **insect pollinator**, we analyzed floral spectra in models of honey bee vision and asked **if invasive floral species exploit sensory biases of honey bees**. Do they have **more salient colors** than native flowers, which make them more attractive and detectable?

2. Methods

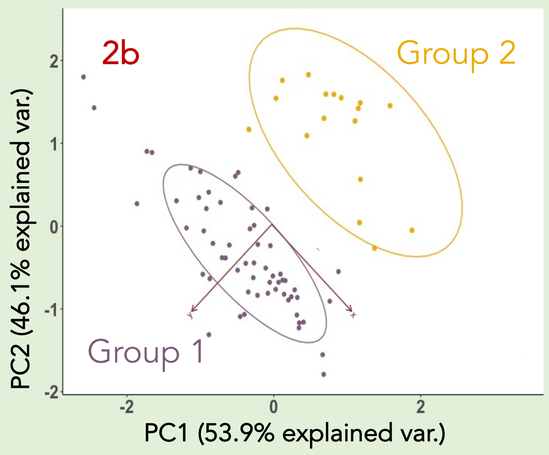
A) Reflectance Spectra

Flower spectra in the range of bee vision (300-650 nm).

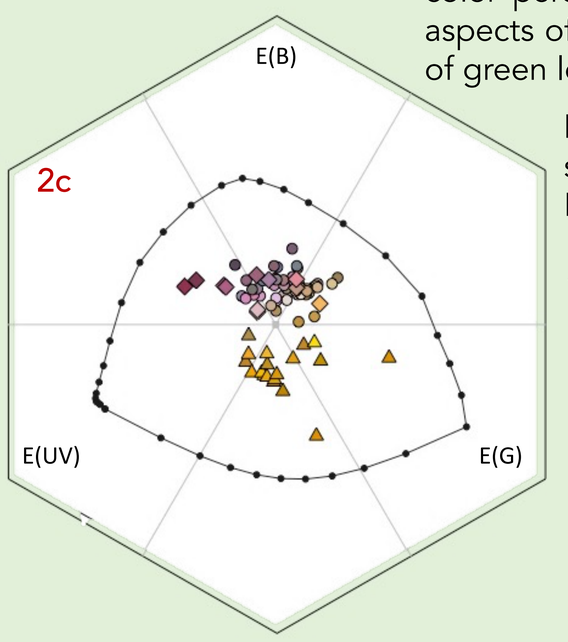


B) PCA Analysis

Based on **k-means** clustering of flowers coordinates in the Hexagon space and **PCA analysis**, 2 groups of flowers were identified.



C) Hexagon space

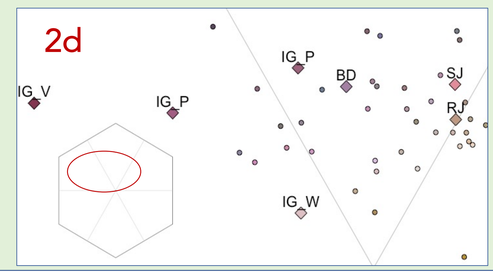


Flower colors were represented in the **Color Hexagon,** a color perceptual space for bees based on physiological aspects of their visual processing. An average reflectance of green leaves was used as background.

E(UV), E(B), E(G): photoreceptor excitations; the spectral curve encloses the colors visible to bees. Each locus corresponds to a flower species.

*A **detail** of the central region of the hexagon (Fig. 2d) (i.e. less saturated colors) shows the loci of the invasive species.*

Group 1
Invasive
Group 2

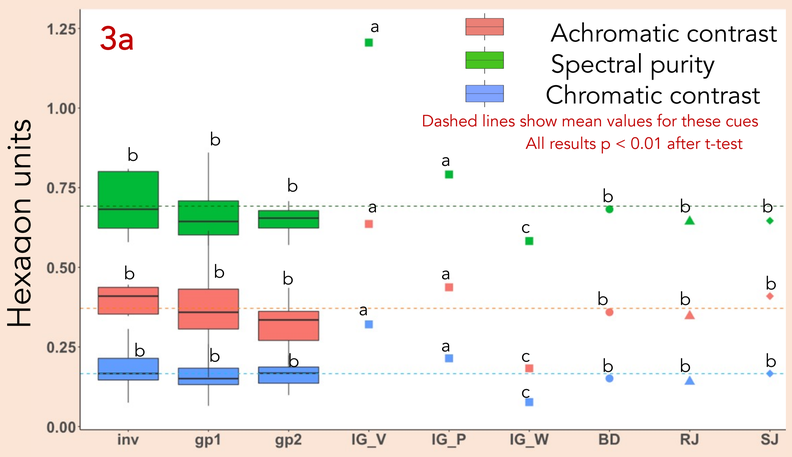


3. Results

A) Analysis of visual cues: Do invasive species have more salient visual cues for pollinator vision?

3 cues representing saliency (Chromatic contrast, achromatic contrast and **spectral purity)** were compared.

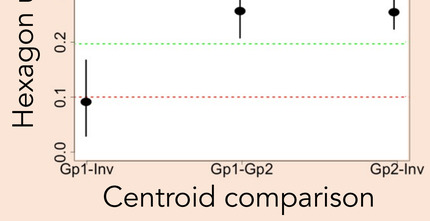
Average **invasive** values (Inv) did not differ from average **Group 1** (gp1) and **Group 2** (gp2) values.

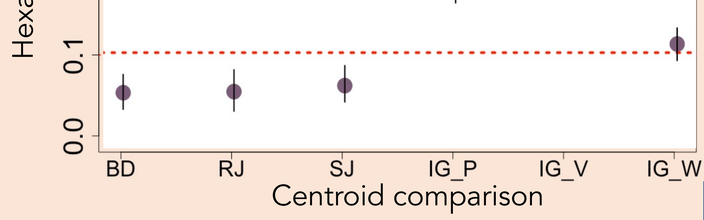


Yet, taken separately, **IG Pink** and **IG Violet have more salient visual traits than native** flowers. **BD, SJ, RJ and IG White** do not have more salient traits than **native** flowers.

B) Centroid comparison: Are pollinators able to discriminate invasive flowers from native flowers?

Color distances were calculated and arithmetic mean position of all points from each group (**centroid**) were compared to a honeybee **visual** discrimination **threshold.**





- Pollinators can discriminate **all invasive flowers** from **Group 2** (Fig. 3b, 3c).
- Pollinators can only discriminate **IG Pink** and **IG Violet** from **Group 1** (Fig. 3c).

4. Discussion

Invasive flowers adopt two main **strategies** to compete for **pollinators** in the **French Pyrenees,** which differ according to the species considered:

- Appear **similar** to native flowers that **surround them** (IG White, BD, SJ, RJ), which may induce color generalization and favor accross-species visits.
- On the contrary, being **more salient** with **enhanced detectability** (IG Pink and IG Violet), which may increase pollinator attraction with respect to local flowers.

Further analyses are suggested to understand how plant-pollinator interactions may contribute to the spread of invasive floral species in the Pyrenees:

- Flower **nectar** and **odor** analysis
- **Behavioral** experiment and in situ observation
- Plant **morphology**, **reproduction** and **phenology** study

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