Variation in Floral Morphology in Endemic *Oenothera harringtonii*

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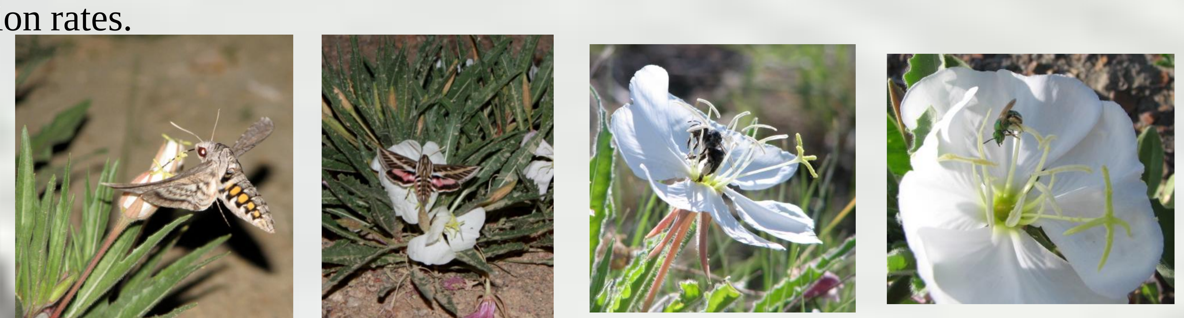
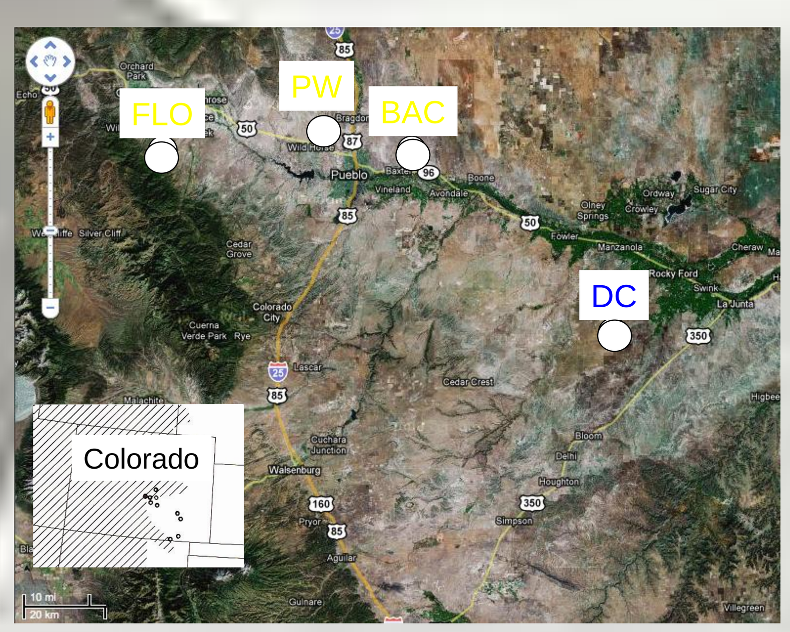
Introduction

More than 70% of the world's flowering plant species depend on insect pollinators for Habitat fragmentation due to human activities often has a distinct impact on populations of flowering plant species, more than seventy percent of which depend on insect pollinators for reproduction (Skogen, pers. comm.). Habitat fragmentation does not affect all plant and pollinator species equally. The small, isolated populations that typically result from habitat fragmentation may not be as easily found by primary pollinators and can lead to inbreeding, morphological, genetic and demographic changes (Skogen, pers. comm.). However, plant species that rely on pollinators that can travel great distances (hawkmoths, birds) may not be affected by habitat fragmentation to the same extent as those that rely on pollinators that travel short distances (bees). *Oenothera harringtonii* (Harrington's Evening Primrose, Onagraceae) may be an especially sensitive indicator of short- and long-term effects of habitat fragmentation due its endemism, self-incompatibility and reliance primarily on hawkmoths for pollination. The landscape in which *O. harringtonii* occurs has been fragmented by urban and recreational development and additional land use alterations. Current populations are found in both fragmented and unfragmented areas and therefore provide an opportunity to determine whether this species has been negatively impacted by habitat fragmentation. Pollinator observations in 2009 showed that hawkmoths were the primary visitors of *O. harringtonii*, while visitation by locally foraging bee was rare in both fragmented and unfragmented populations (unpublished data). Because different pollinator species are attracted and respond to different floral cues, floral morphology may be under strong selective pressures. We tested the following hypotheses to determine whether differences in floral morphology might be explained by habitat fragmentation and differences in pollinator visitation rates.



A. *Manduca quinquemaculata,* B. *Hyles lineata*, C. *Anthophora sp.* D. Agapostemon sp.



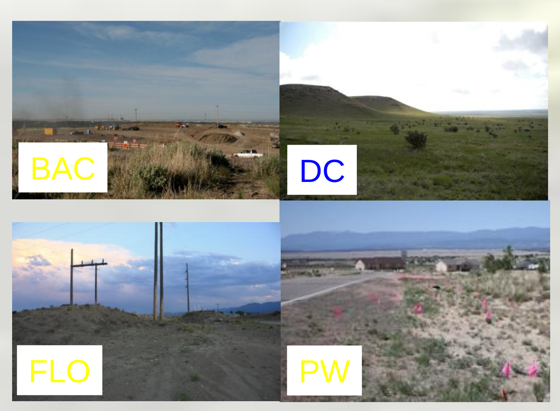


Figure 1. Map of fragmented and unfragmented field sites (A) and images of sites (B).

Hypotheses

We compare floral morphology data collected from 4 populations in the field in 2009 and 2010 and a common garden experiment.

1) Patterns of variation in floral traits observed in the common garden differ from those found in wild populations.
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2) **Plants from fragmented populations have smaller floral characteristics.**

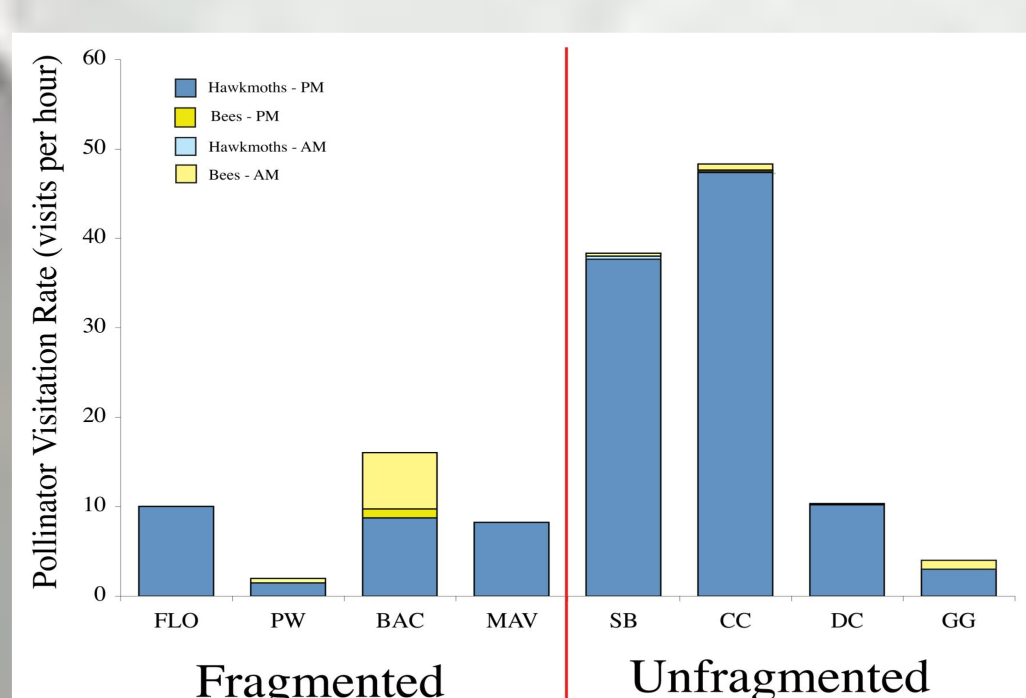
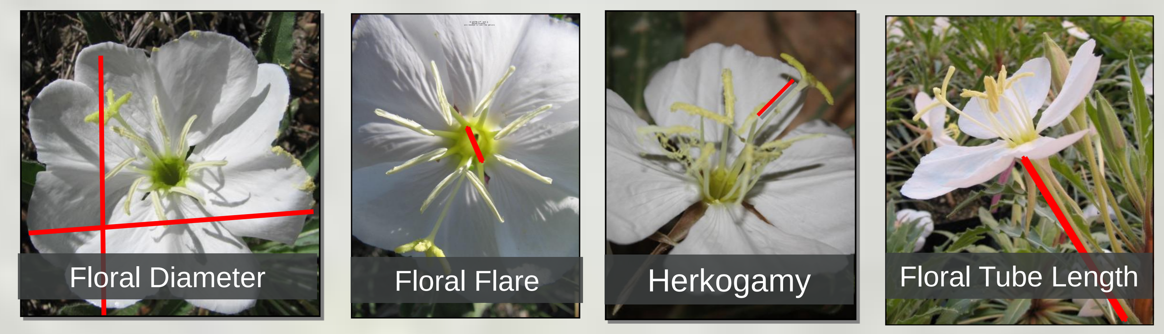


Figure 2. Pollinator visitation rates in fragmented and unfragmented populations in 2009.

Hawkmoth visitors travel long distances.

Results



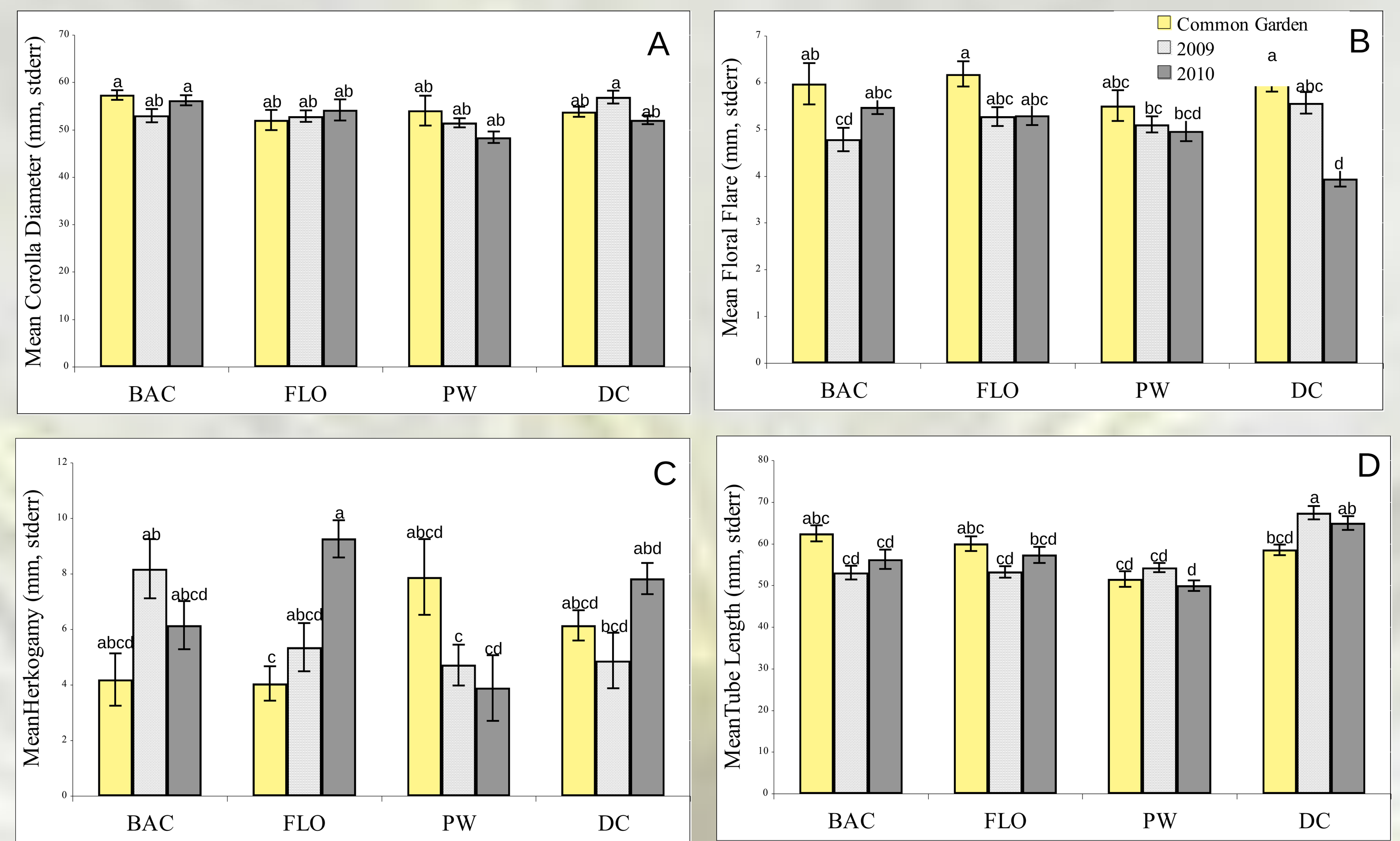


Figure 3. Variation among field seasons 2009, 2010 and the common garden in floral traits corolla diameter(A), herkogamy(B), floral flare (C), and tube length(D) in 4 populations.

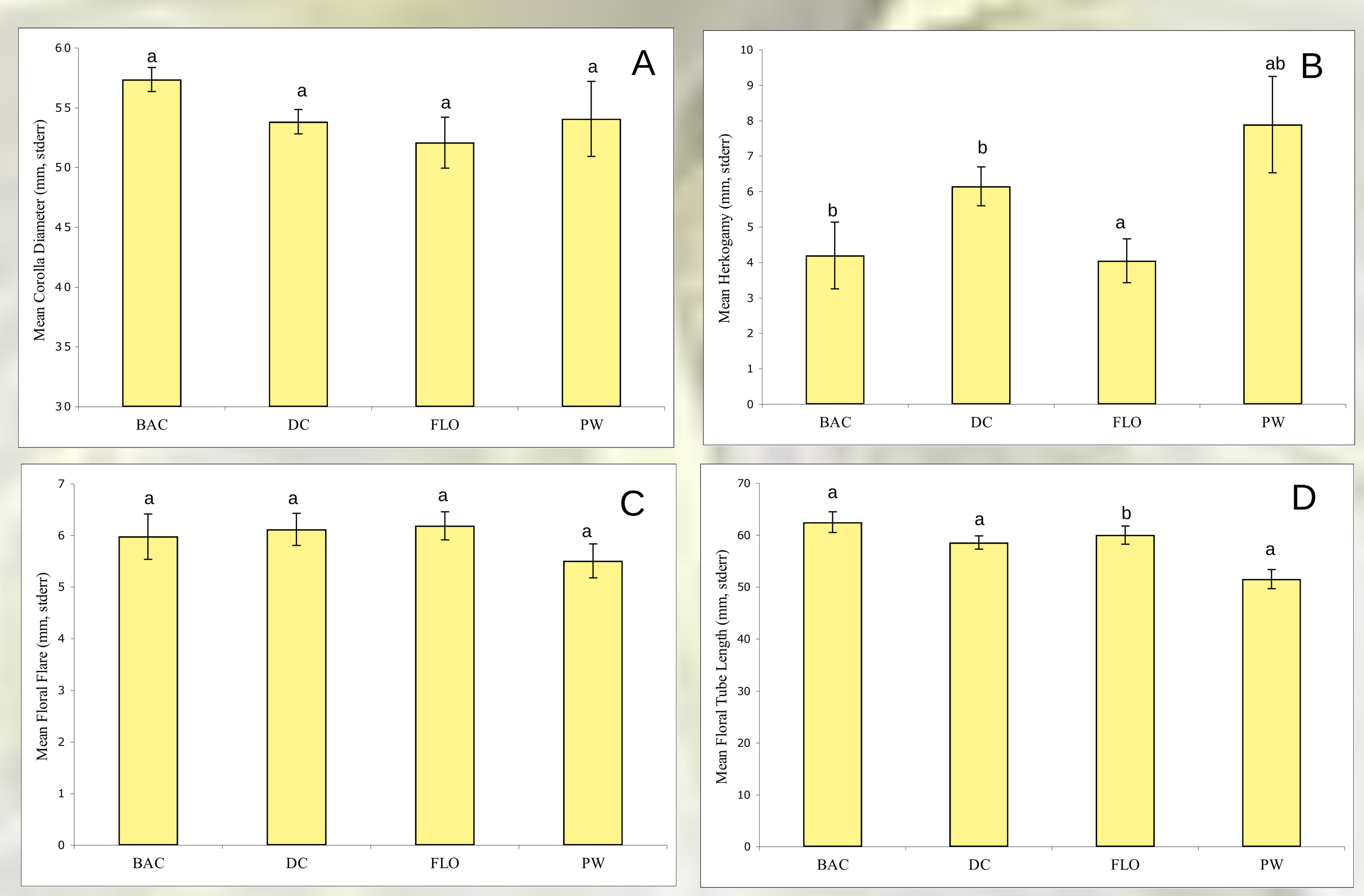


Figure 4. Variation among populations in the common garden for floral traits corolla diameter(A), herkogamy(B), floral flare (C), and tube length(D).

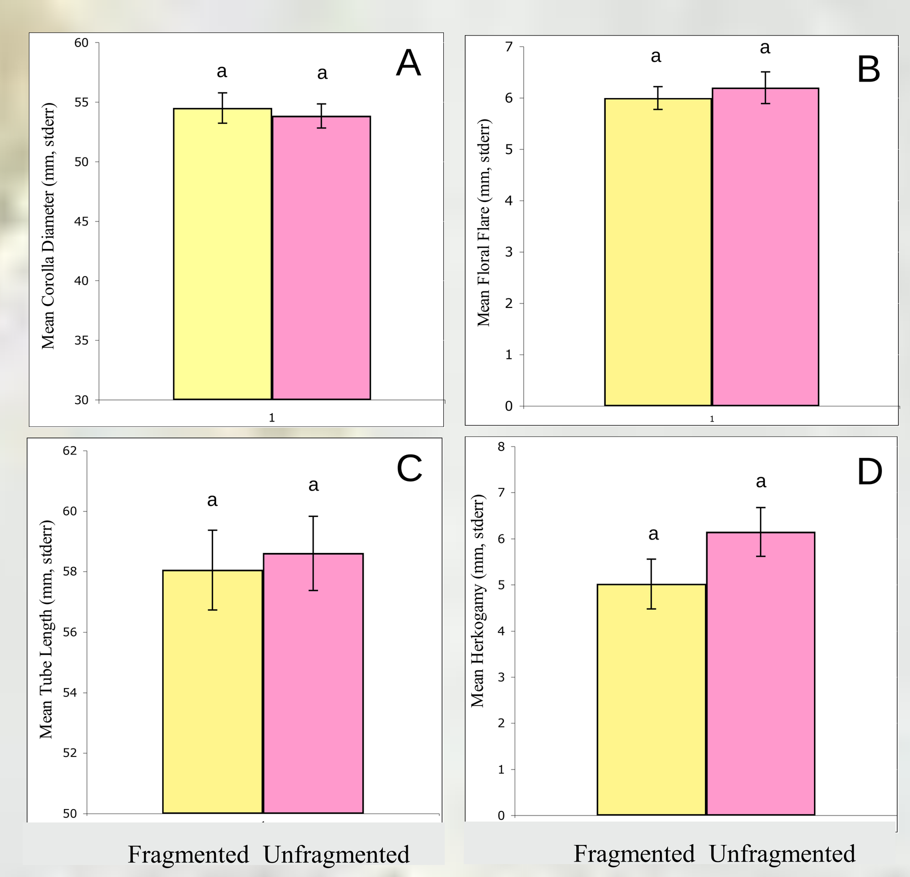


Figure 5. Variation in floral traits compared between fragmented and unfragmented populations represented in the common garden for floral traits corolla diameter(A), floral flare (B), tube length (C), and herkogamy (D).

Discussion

Hypothesis 1: Patterns of variation in floral traits observed in the common garden differ from those found in wild populations.

This hypothesis was not supported. The variation observed in the common garden was similar to that found in wild populations in 2009 and 2010.

We observed significant differences in some floral traits but these differences did not follow a common pattern across populations nor in comparisons among plants grown in the common garden and those measured in the field in 2009 and 2010.

- Mean herkogamy was significantly lower in BAC and FLO than in PW.
- Mean tube length was significantly shorter in PW than in DC, BAC and FLO.
- There were no significant differences in mean corolla diameter or floral flare among populations.

Hypothesis 2: Plants from fragmented populations have smaller floral characteristics.

This hypothesis was not supported. We did not find significant differences in fragmented and unfragmented populations in any of the floral traits measured in the common garden.

Conclusions

These data suggest that environmental variation likely explains much of the variation observed in field-collected data.

While hawkmoth visitation rates were lower in 2009, the common garden data suggest that variation in floral traits in fragmented and unfragmented populations that were observed in the field in 2009 likely resulted from environmental variation.

- These data suggest that gene flow may still be occurring between fragmented and unfragmented populations.
- These data suggest that gene flow may still be occurring between fragmented and unfragmented populations.
- Environmental factors associated with fragmentation include proximity to road surfaces that alter levels of water intake and loss as well as soil disturbance due to development. These conditions have been shown to impact *O. harringtonii* and may account for some of the field variation between populations.

Effects of habitat fragmentation are not maintained in populations of *O. harringtonii.*

These data suggest that the floral traits we measured have not responded to fragmentation, which may be explained by patterns of pollen dispersal (gene flow) resulting from pollination events by long distance pollinators (hawkmoths).

Although this data set suggests that habitat fragmentation has not had a negative impact on *O. harringtonii*, we cannot rule out this possibility due to the small size of the data set and the relatively short time in which *O. harringtonii* habitat has been subject to fragmentation.

Methods

Common Garden
Fruits were collected from *O. harringtonii* individuals during the 2008 field season and were used in hand pollinations in the Chicago Botanic Gardein in winter 2008-2009. Seeds resulting from within- and among population crosses (Table 1) were germinated in petri dishes, transferred to planting flats of potting soil greenhouse and transplanted into a common garden at the Chicago Botanic Garden in late May. Aggressive species such as grasses and ground cover were removed periodically to reduce competition and improve growing conditions.

2009 and 2010 Field Data
Floral morphology data were collected on 15-30 plants in each of 4 populations in both years (Table 1).

Floral Morphology
Open flowers were removed on the night they bloomed or the following morning. Up to 10 flowers per plant were measured. The following floral characteristics were measured to the nearest tenth of a millimeter using a digital caliper.
Corolla diameter: distance between the outermost edge of opposite petals. Two measurements per flower were averaged.
Herkogamy: distance in the vertical plane between the nearest anther and stigma.
Floral Flare: diameter of the flare at the top of the floral tube.
Floral Tube Length: distance from the top of the ovary to the insertion point of the sepals.

Statistical Analysis
Data were analyzed using AnOVA and Tukey HSD in JMP 5.0.1 (SAS Institute, Inc.). Levels not sharing the same letter represent significant differences at the $P = 0.05$ level.

Acknowledgements

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