Unveiling the Invisible: Climate's Influence on Floral UV Patterns in Mimulus Guttatus

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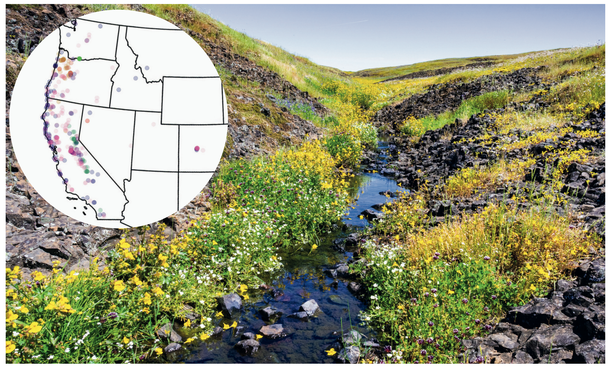

IMAGE 1: SEEP MONKEY FLOWER (MIMULUS GUTTATUS) AND WHITE MEADOW FOAM (LIMNANTHES ALBA) WILDFLOWERS BLOOMING ON THE SHORES OF A CREEK, NORTH TABLE MT. ECOLOGICAL RESERVE, OROVILLE, CALIFORNIA, WITH RANGE OF SPECIATION.

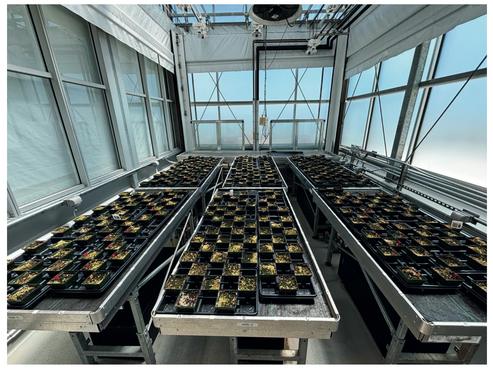

IMAGE 2: YALE SCIENCE BUILDING ROOFTOP GREENHOUSE LABORATORY

MIMULUS GUTTATUS FLOWERS DISPLAY COMPLEX PIGMENTATION: ANTHOCYANINS CREATE REDDISH PATTERNS VISIBLE TO HUMANS, WHILE UV-ABSORBING FLAVONOIDS FORM 'BULL'S-EYE' PATTERNS VISIBLE ONLY TO POLLINATORS, SERVING AS NECTAR GUIDES AND UV PROTECTION. THIS STUDY EXPLORES HOW CLIMATE SHAPES THESE OVERLAPPING YET DISTINCT PIGMENT SYSTEMS ACROSS DIVERSE HABITATS, INVESTIGATING THEIR ROLE IN PLANT-POLLINATOR INTERACTIONS AND ADAPTATION TO LOCAL ENVIRONMENTS.

1 HYPOTHESES

- UV PIGMENTATION INTENSIFIES AT HIGHER ELEVATIONS AND LATITUDES, POSSIBLY DUE TO INCREASED UV EXPOSURE.
- REGIONS WITH GREATER TEMPERATURE FLUCTUATIONS THROUGHOUT THE YEAR MAY SHOW MORE VARIABLE UV PATTERNS.
- AREAS WITH HIGHER ANNUAL RAINFALL MIGHT SUPPORT INCREASED UV PIGMENT PRODUCTION.
- PLANTS IN EXTREMELY COLD ENVIRONMENTS MAY DEVELOP MORE EXTENSIVE UV PIGMENTATION AS A PROTECTIVE MEASURE.

2 METHODOLOGY

- SAMPLED 888 ACCESSIONS FROM 368 M. GUTTATUS POPULATIONS
- UV PHOTOGRAPHY OF FLOWERS USING MODIFIED CAMERA AND FILTERS
- IMAGE ANALYSIS WITH IMAGEJ TO QUANTIFY UV-ABSORBING AREAS
- EXTRACTION OF 19 BIOCLIMATIC VARIABLES FOR EACH POPULATION
- STATISTICAL ANALYSES: CORRELATION, REGRESSION, GWAS

IMAGE 3: MIMULUS GUTTATUS' PIGMENTATION VARIATION

IMAGE 4: MODIFIED CANON REBEL T7 AFFIXED WITH BAADER UV BANDPASS FILTER

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IMAGE 5: #339-1 CLOSE-UP

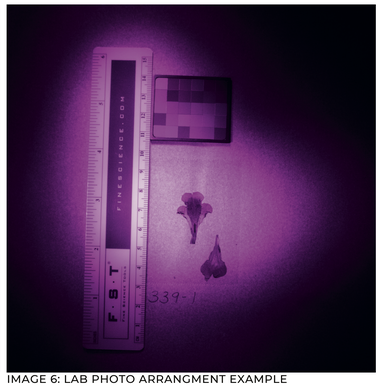

IMAGE 6: LAB PHOTO ARRANGMENT EXAMPLE

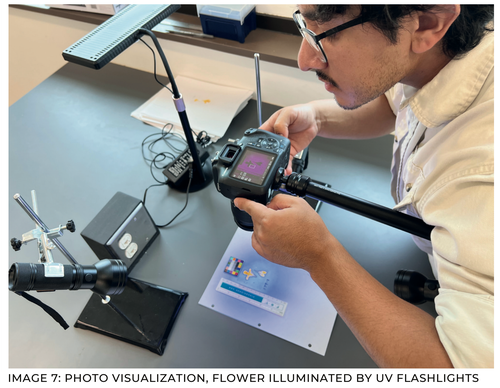

IMAGE 7: PHOTO VISUALIZATION, FLOWER ILLUMINATED BY UV FLASHLIGHTS

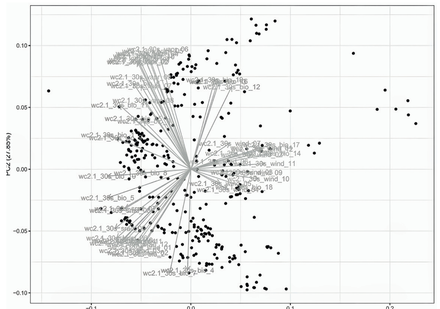

IMAGE 8. PRINCIPAL COMPONENT ANALYSIS (PCA) OF PC1 AND PC2

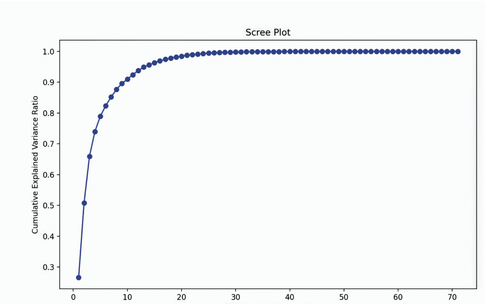

IMAGE 9: SCREE PLOT SHOWING CUMULATIVE VARIANCE EXPLAINED BY PRINCIPAL COMPONENTS, WITH 5-6 PCS CAPTURING 80-85% OF TOTAL VARIANCE IN M. GUTTATUS UV PATTERN DATA.

3 RESEARCH

- THE FIRST TWO PRINCIPAL COMPONENTS ACCOUNT FOR 50.77% OF THE TOTAL VARIANCE IN THE DATA.
- TOP CONTRIBUTING FACTORS TO PC1 ARE PRIMARILY TEMPERATURE-RELATED BIOCLIMATIC VARIABLES (E.G., BIO1: ANNUAL MEAN TEMPERATURE, BIO5: MAX TEMPERATURE OF WARMEST MONTH, BIO10: MEAN TEMPERATURE OF WARMEST QUARTER) AND PRECIPITATION-RELATED VARIABLES (E.G., BIO14: PRECIPITATION OF DRIEST MONTH, BIO17: PRECIPITATION OF DRIEST QUARTER).
- PC2 IS DOMINATED BY VAPOR PRESSURE VARIABLES, INDICATING THE IMPORTANCE OF ATMOSPHERIC MOISTURE CONTENT.
- THE FIRST FIVE PRINCIPAL COMPONENTS EXPLAIN 78.97% OF THE TOTAL VARIANCE, SUGGESTING A COMPLEX INTERPLAY OF MULTIPLE ENVIRONMENTAL FACTORS.

4 ANALYSIS

- SCREE PLOT ANALYSIS INDICATES THAT 5-6 PRINCIPAL COMPONENTS CAPTURE 80-85% OF THE TOTAL VARIANCE, PROVIDING A BALANCED REPRESENTATION OF THE DATA'S COMPLEXITY.
- PCA EFFECTIVELY HANDLED CORRELATED CLIMATE VARIABLES, REVEALING THE MOST INFLUENTIAL FACTORS AFFECTING M. GUTTATUS UV PATTERNS.
- KEY BIOCLIMATIC VARIABLES EXPLAINING MOST VARIATION IN UV PATTERNS INCLUDE:
- BIO1: (ANNUAL MEAN TEMP), BIO5 (MAX TEMP OF WARMEST MONTH), BIO10 (MEAN TEMP OF WARMEST QUARTER), BIO14 (PRECIPITATION OF DRIEST MONTH), BIO17 (PRECIPITATION OF DRIEST QUARTER)
- VAPOR PRESSURE, PARTICULARLY IN MONTHS 4-6, EMERGED AS A SECONDARY BUT SIGNIFICANT FACTOR.
- FINDINGS SUGGEST THAT TEMPERATURE, PRECIPITATION, AND ATMOSPHERIC MOISTURE CONTENT ARE THE PRIMARY DRIVERS OF UV PATTERN VARIATION IN M. GUTTATUS.

5 CONCLUSION

- M. GUTTATUS UV PATTERNS SHOW SIGNIFICANT CLIMATE-ASSOCIATED VARIATION
- RESULTS SUGGEST ADAPTIVE RESPONSES TO LOCAL ENVIRONMENTAL CONDITIONS
- FINDINGS IMPLY COMPLEX INTERPLAY BETWEEN ABIOTIC FACTORS AND PLANT-POLLINATOR INTERACTIONS
- FUTURE WORK: EXPERIMENTAL VALIDATION AND INVESTIGATION OF SPECIFIC GENE FUNCTIONS IN UV PATTERNING

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