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Final Report

Seed Germination and Dormancy of *Pentachaeta lyonii*

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Introduction

Pentachaeta lyonii Gray [*Chaetopappa lyonii* in Munz, 1968] is a short-lived annual plant in the sunflower family (Asteraceae). It is a state listed endangered plant and candidate for federal listing.

Pentachaeta habitat is a rather open herbaceous community often distributed in gaps within chaparral and other shrublands. *Pentachaeta* apparently competes poorly with annual grasses such as species of *Avena* and *Bromus* as dense growth by these non-natives appears to preclude it from a site. *Pentachaeta* is often associated with native perennial bunchgrasses such as *Nasella lepida* and *N. pulchra* and a number of rather diminutive native annuals.

Pentachaeta exists at the ecotone of shrubland and grassland or within sizeable gaps in the shrubland vegetation. It is not a true "grassland" species but rather forms a unique herbaceous community with other non-grassland species such as *Nasella lepida*.

Disturbances, such as soil scraping by construction equipment, appear to favor the species on some sites, particularly if soil depth is insufficient to maintain dense annual grass growth. For example, most populations at the Lake Eleanor Hills development site seemed to have expanded the limits of their distribution in response to such disturbance.

Disturbance by wildfire may promote *Pentachaeta* by removing shrubs that prevent its establishment but the exact relationship between fire and this rare plant remains to be determined. While other annual species that are associated with chaparral are known to possess a dormant soil-stored seed bank that is stimulated to germinate by fire (Keeley 1991), relatively little is known about *Pentachaeta* germination physiology. Germination very likely occurs during the winter rainy season but the exact temperature conditions required are not known. It is also unknown whether a portion of the seed bank is dependent upon a fire related cue (e.g., Keeley 1991) such as heat, chemicals leached from charred wood or smoke.

The purpose of these studies was to determine the potential for development of a dormant soil-stored seed bank that is dependent upon disturbance such as fire for germination and potential for soil carry-over during years of drought. This study examines the seed germination physiology of *Pentachaeta lyonii*, examining its response to different temperature conditions and fire related cues. In addition, seed longevity of soil-stored seed was evaluated on seeds stored in soil for 6 and 9 months.

Methods

Seeds were collected in the field from Lk Eleanor Hills in the Santa Monica Mtns., Ventura Co (site described in Baier et al. 1990). Seeds were stored for approximately 2 years in paper bags under room conditions.

For each experimental treatment 50 seeds were counted out into a filter paper lined petri dish (n = 5 replicates). Seeds were wetted with distilled water with dilute fungicide. Treatments, including some not specified in the original proposal, were as follows:

For burial experiments, 50 seeds were counted out and placed in small nylon bags and buried in soil (soil collected from a *Pentachaeta* site) to a depth of 3 cm. A total of 10 bags were buried. These soils were stored outside and exposed to normal atmospheric conditions and not watered, except for natural precipitation events. Half of the bags were excavated in autumn and germination assessed under "control" (Treatment I described below) conditions. The other half of the samples were excavated in mid-winter and tested as above.

Definitions:

Treat	=	Treatment number
Heat	=	Heat shock treatment prior to wetting
Smoke/char	=	Exposure to 15 min of wood smoke prior to wetting or incubation in petri dishes with charred wood
Strat	=	Stratified at 5 C for 30 days following wetting
Incub	=	Temperature regime seeds were incubated after stratification (12 hr/12 hr)
Light	=	Incubated in the light (12 hr/12 hr dark) or only in the dark

Treatments were as follows:

Treat	Heat	Smoke/Char	Strat	Incub	Light
Control → I	0	no	yes	20/12C	yes
II	80C/1hr	no	yes	20/12C	yes
III	100C/5min	no	yes	20/12C	yes
IV	110C/5min	no	yes	20/12C	yes
V	0	smoke	yes	20/12C	yes
VI	0	char	yes	20/12C	yes
VII	0	no	yes	20/12C	no
VIII	0	no	yes	20/20	yes
IX	0	no	no	20/12	yes
X	0	no	no	35/20	yes
XI	0	no	no	20/20	yes
XII	0	no	yes	none	yes

Germination data were arcsine transformed and treatments compared with one-way ANOVA and pairwise comparisons of means with Fishers LSD.

Results and Discussion

Germination of room-stored seed:

Percentage germination for these studies are shown in Table 1. Approximately, 60% of *Pentachaeta* seeds germinated without any treatment designed to mimic fire or other disturbance. Treatments such as smoke, charred wood, and heat shock did not stimulate germination. Table 2 shows pairwise comparisons of treatment means. In general, it is apparent that heat shock treatments and smoke significantly reduced germination.

Tentatively, I can draw the following conclusions.

1. A substantial proportion of the seed pool germinates without any fire type stimulus such as heat shock, smoke or charred wood.
2. Seed germination is largely light neutral.
3. Seed germination has a very broad temperature profile over which germination occurs.
4. Seed germination is not highly dependent upon a cold stratification period prior to incubation.

Soil-Stored Seeds:

Seeds excavated after 6 months and 9 months of outdoor soil storage yielded no germination. Based on seed coat remnants, it appeared as though half or more of the original seeds had germinated but due to burial the seedling had disintegrated.

Conclusions and Recommendations

In summary, *Pentachaeta lyonii* seeds seem to germinate readily without requiring any fire-related cue or seasonal cue. There is no evidence that this species maintains a dormant seed bank. This seems surprising in light of the known annual fluctuations in population size that has been documented for some populations (Baier et al. 1991). The results from this study would suggest that annual fluctuations are not the result of differential germination from year to year. Rather, it appears more likely that annual patterns of population size are the result of differential seedling survival. This tentative conclusion is critical to management of this species and therefore further experiments designed to assess the extent of soil-seed storage would be valuable. I suggest that studies designed to be done in the field on soils in place would be worthwhile.

References and Personal Communications

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Table 1. Preliminary Germination Results for *Pentachaeta lyonii*
(n=3 dishes of 50 seeds)

	Heat	Smoke/Char	Strat	Incub	Light	Germination(%)
						$\bar{X} \pm SE$
I	0	no	yes	20/12C	yes	**57 ± 3**
II	80	no	yes	20/12C	yes	**53 ± 3**
III	100	no	yes	20/12C	yes	**40 ± 3**
IV	110	no	yes	20/12C	yes	**37 ± 3**
V	0	smoke	yes	20/12C	yes	**41 ± 3**
VI	0	char	yes	20/12C	yes	**52 ± 3**
VII	0	no	yes	20/12C	no	**50 ± 4**
VIII	0	no	yes	20/20	yes	**51 ± 3**
IX	0	no	no	20/12	yes	**53 ± 3**
X	0	no	no	35/20	yes	**48 ± 4**
XI	0	no	no	20/20	yes	**60 ± 4**
XII	0	no	yes	none	yes	**59 ± 4**

Table 2. FISHER'S LEAST-SIGNIFICANT-DIFFERENCE TEST. MATRIX OF PAIRWISE COMPARISON PROBABILITIES:

	1	2	3	4	5
1	1.000				
2	0.441	1.000			
3	0.000	0.003	1.000		
4	0.000	0.000	0.496	1.000	
5	0.000	0.004	0.856	0.389	1.000
6	0.319	0.820	0.005	0.001	0.009
7	0.184	0.482	0.072	0.019	0.098
8	0.161	0.525	0.016	0.002	0.025
9	0.341	0.856	0.004	0.001	0.008
10	0.122	0.355	0.113	0.034	0.150
11	0.505	0.196	0.000	0.000	0.000
12	0.711	0.318	0.001	0.000	0.001

	6	7	8	9	10
6	1.000				
7	0.604	1.000			
8	0.683	0.853	1.000		
9	0.964	0.578	0.650	1.000	
10	0.459	0.847	0.683	0.437	1.000
11	0.140	0.085	0.072	0.150	0.056
12	0.237	0.142	0.131	0.252	0.097

	11	12
11	1.000	
12	0.797	1.000

2-4 heatshock
5. smoke
6 charate