

Comparison of *Dichelostemma capitatum* Subspecies Reveals Variation in Life Cycle Parameters

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ABSTRACT

Dichelostemma capitatum (Benth.) Alph. Wood is a geophyte (herbaceous perennial with underground storage organs) with three subspecies in California. Plants from populations of *D. capitatum* subsp. *capitatum* and *D. capitatum* subsp. *lacuna-vernalis* (L. Lenz) D.W. Taylor grown under common garden conditions maintain their diagnostic morphological distinctions and also demonstrate differences in their life cycle parameters. Although both subspecies share many traits in common, *D. capitatum* subsp. *lacuna-vernalis* has shorter scapes and fewer flowers per scape, transitions from the juvenile stage to the reproductive stage at a smaller corm size, and rarely produces cormlets. Larger corms produce plants with more scapes and more flowers, but the effect on scape number is more pronounced in *D. capitatum* subsp. *lacuna-vernalis*, and the effect on flower number is more pronounced in *D. capitatum* subsp. *capitatum*. The differences seen in *D. capitatum* subsp. *lacuna-vernalis* may be associated with life in a “flashy” habitat, i.e., thin soils that rapidly dry up in early spring. In addition, the effects varied from year to year, suggesting that environmental variation may affect the expression of growth and reproductive characters.

METHODS

Corms were initially collected from multiple populations of *D. capitatum* subsp. *capitatum* and *D. capitatum* subsp. *lacuna-vernalis* during a previous morphometric study. Prior to planting, the corms were pooled, measured, and sorted into 8 diameter classes: 3–5 mm, 5–8 mm, 8–11 mm, 11–14 mm, 14–17 mm, 17–20 mm, 20–23 mm, and 23–26 mm. Corm diameter was determined as an average of two or three measurements made with calipers (to the nearest 0.1 mm) at different positions, to account for asymmetry. The corms were planted in 20-cm diameter pots using a commercial potting mix. Ten corms were planted in each pot at a depth of 10 cm. The first plantings were done in early October, 2011, at the start of the rainy season. The plants were grown together outdoors in Davis, California (38° 33.7' N, 121° 43.8' W, elevation 15 m), under conditions of ambient temperature, light, and rainfall, with occasional supplemental watering. In 2012 and 2013, corms were used from the previous year’s plantings.

During the growth season, the following parameters were determined: maximum leaf width, percentage of scapes flowering, number of scapes, scape height, number of flowers per scape, daughter corm size, and number of cormlets produced.

LEAF WIDTH

- Leaf width is correlated with corm diameter and generally is an indicator of corm age

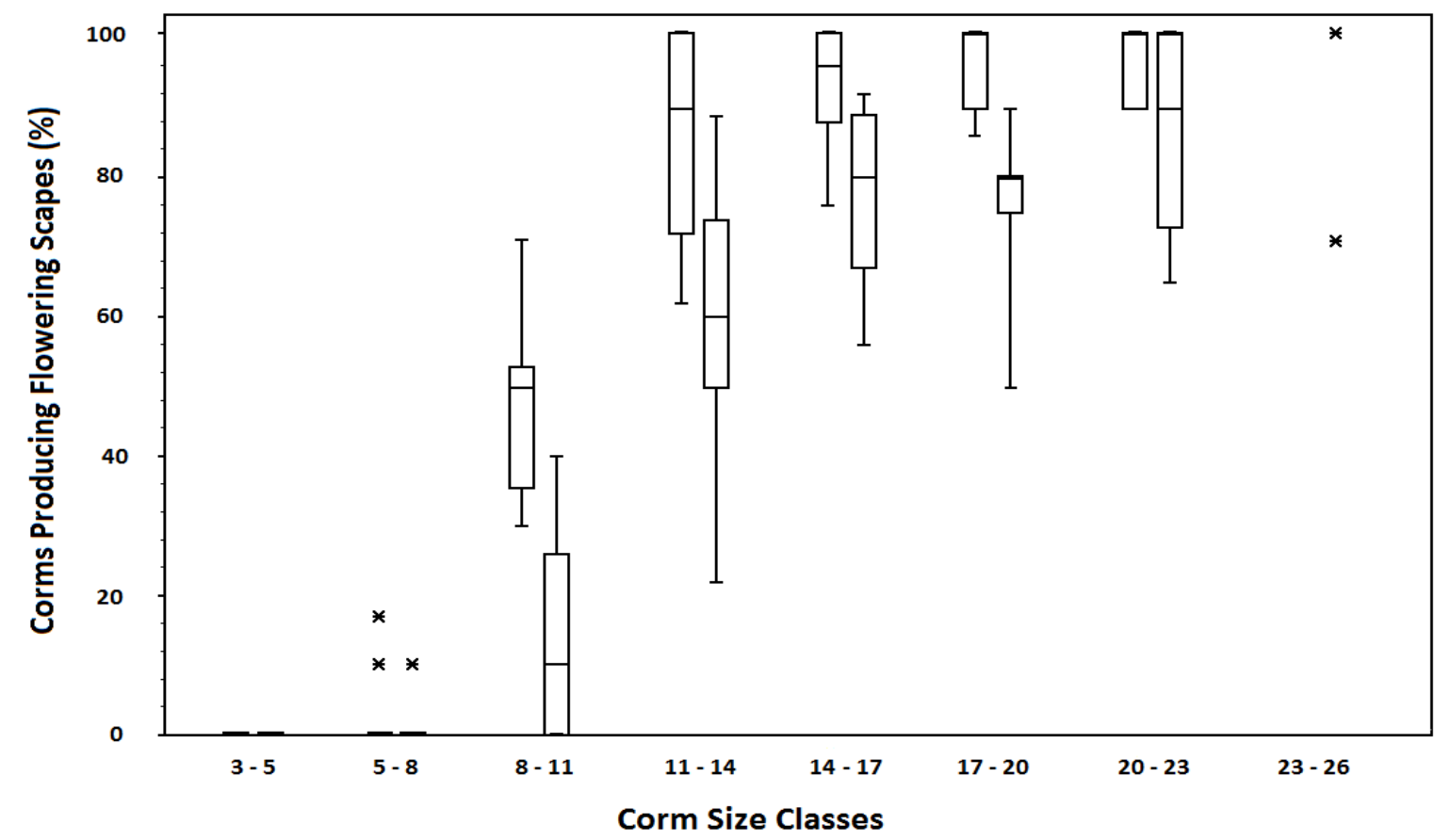
Seedlings and young, pre-reproductive plants produce a single terete leaf, and mature plants produce two, rarely three leaves (A). Leaf width is similar in both *D. capitatum* subsp. *capitatum* and *D. capitatum* subsp. *lacuna-vernalis*, although larger corms of *D. capitatum* subsp. *capitatum* generally produce slightly wider leaves.

Corm Size Class (mm)	Leaf Width in mm (range)	
	<i>D. capitatum</i> subsp. <i>lacuna-vernalis</i>	<i>D. capitatum</i> subsp. <i>capitatum</i>
3-5	1.0 (1.0-1.0)	1.0 (0.8-2.0)
5-8	1.5 (1.0-4.0)	1.7 (1.0-11.8)
8-11	4.5 (1.0-10.0)	3.8 (1.0-14.5)
11-14	6.8 (1.8-12.3)	7.4 (2.0-14.0)
14-17	8.6 (3.5-14.2)	9.3 (2.0-18.3)
17-20	9.4 (5.0-16.0)	11.8 (3.0-23.0)
20-23	11.3 (6.0-16.0)	14.5 (7.5-23.5)
23-26	—	13.9 (11.0-21.5)

FLOWERING COMPETENCY

- Corms must reach a certain minimum size before becoming competent to produce floral meristems
- *D. capitatum* subsp. *lacuna-vernalis* blooms at a smaller corm size than *D. capitatum* subsp. *capitatum*

As in many geophytes, *D. capitatum* goes through a series of phase changes. In the earliest phase, seedlings and young cormlets do not produce flowers and rarely produce cormlets, focusing most of their effort on establishment and growth. After two or three seasons of growth, the plants shift their effort into reproduction and become competent to bloom. Corms of *D. capitatum* subsp. *lacuna-vernalis* (box plots on left) reach maturity earlier than those of *D. capitatum* subsp. *capitatum* (box plots on right) and have an overall higher percentage of plants flowering.

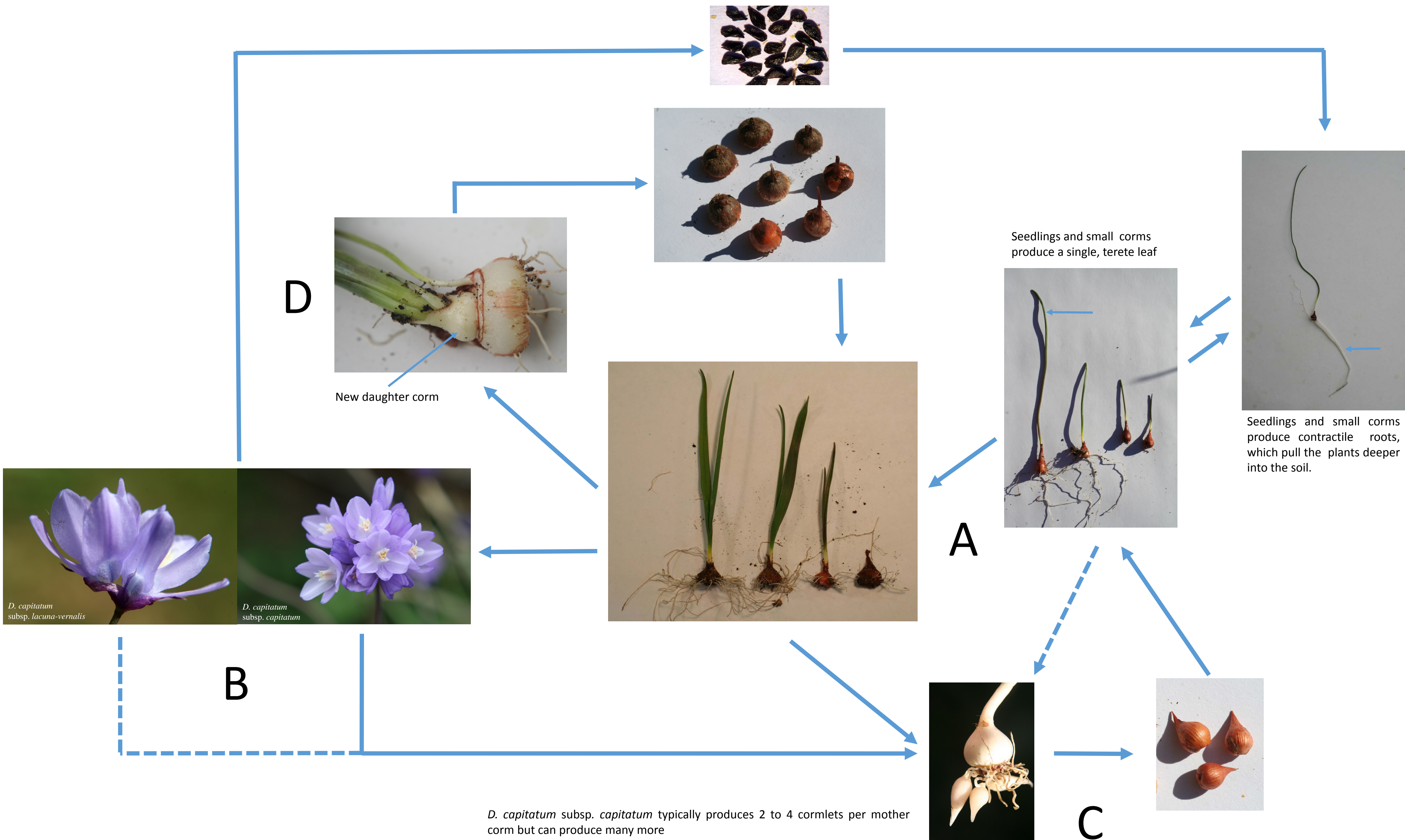


NUMBER OF SCAPES

- Younger plants typically produce a single scape, but older plants are capable of producing several scapes from the same corm
- *D. capitatum* subsp. *lacuna-vernalis* produces more scapes than *D. capitatum* subsp. *capitatum*

As corm size increases, the plants become capable of producing multiple scapes, and larger *D. capitatum* subsp. *lacuna-vernalis* corms can produce up to 8 scapes.

Corm Size (mm)	Mean Number of Scapes per Plant (Range)	
	<i>D. capitatum</i> subsp. <i>lacuna-vernalis</i>	<i>D. capitatum</i> subsp. <i>capitatum</i>
3-5	—	—
5-8	1.0 (—)	1.2 (1-2)
8-11	1.6 (1-4)	1.3 (1-3)
11-14	2.4 (1-5)	1.6 (1-3)
14-17	3.1 (1-6)	1.8 (1-6)
17-20	3.6 (1-6)	1.9 (1-5)
20-23	3.8 (2-8)	2.1 (1-3)
23-26	—	2.5 (2-3)



SCAPE HEIGHT

- Scape height in *D. capitatum* subsp. *lacuna-vernalis* (12.2 cm, range 0.7-29.5 cm) is significantly less than in *D. capitatum* subsp. *capitatum* (27.4 cm, range 3.9-58.9 cm), although the ranges overlap to a small degree
- Scape height does not differ significantly among corm size classes

FLOWERS PER SCAPE

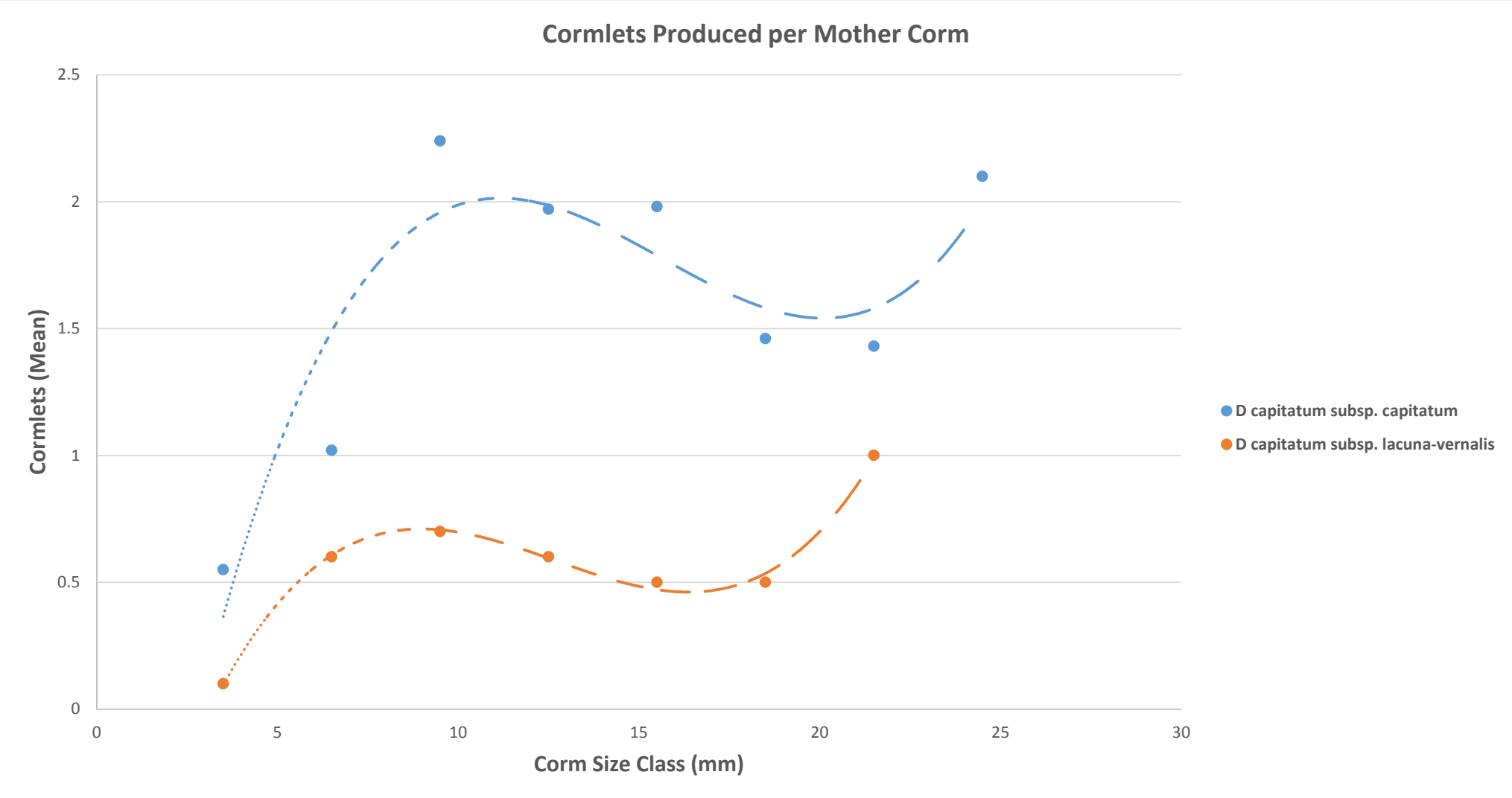
- The number of flowers per scape increases with corm size

Dichelostemma capitatum subsp. *lacuna-vernalis* produces 1–3 flowers per scape (mean = 2.1), very rarely producing as many as 5 flowers (range = 1–5) (B). Flower production in *D. capitatum* subsp. *capitatum* was highly variable, but the plants generally produced many more flowers per scape than *D. capitatum* subsp. *lacuna-vernalis* (mean = 5.3, range = 1–18), rarely producing fewer than 5 flowers.

CORMLETS

- *D. capitatum* subsp. *lacuna-vernalis* produces fewer cormlets than *D. capitatum* subsp. *capitatum*

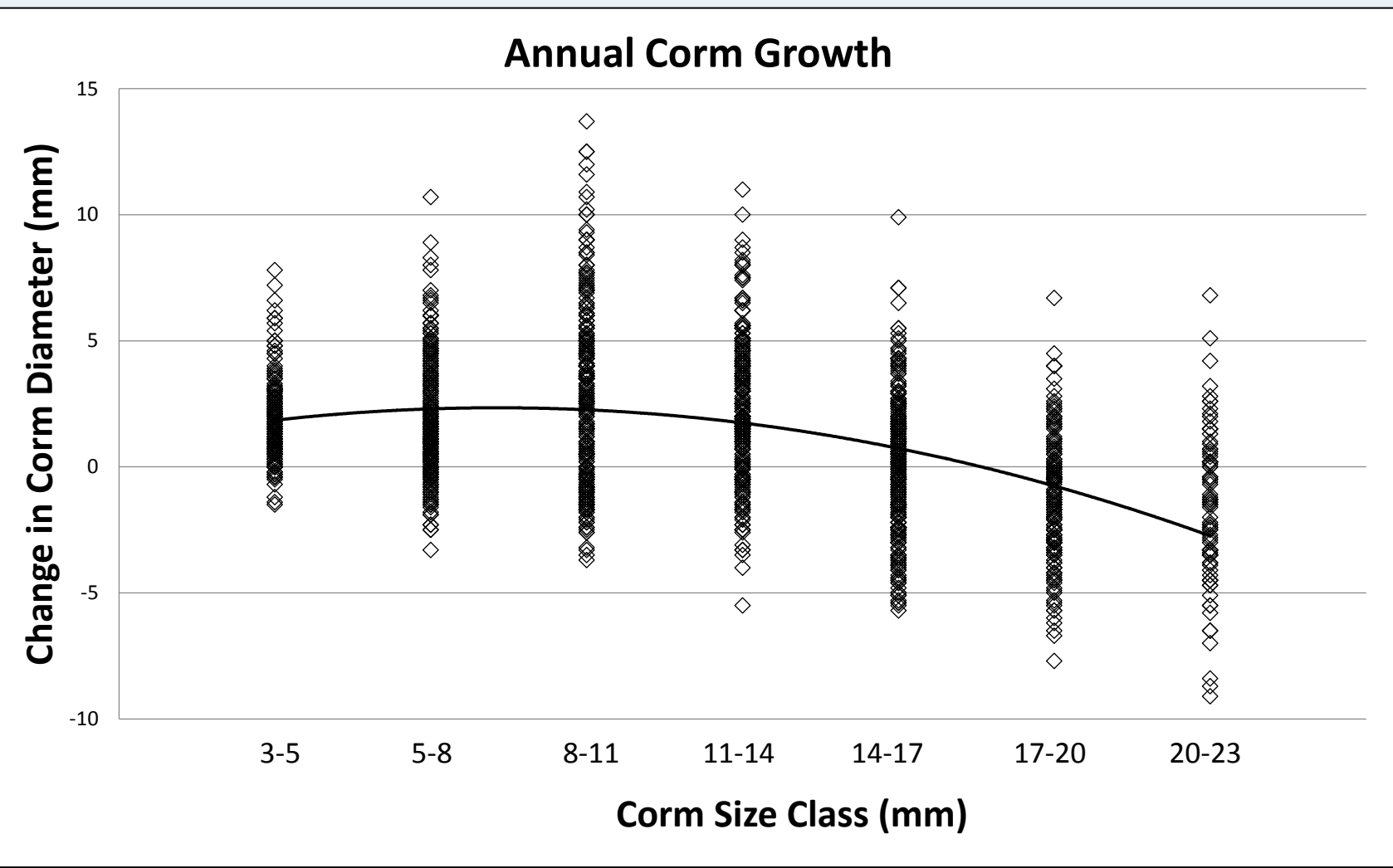
Cormlet production (C) was highly variable and significantly affected by taxon, size class, and planting year. In addition, cormlet production appears to be bimodal, with highest cormlet production occurring in the intermediate size classes and the largest size class.



CORM SIZE

- Daughter corms (D) can be larger or smaller than the mother corms, but in general, they increase in size up to a certain point

Maximum corm diameter appears to be about 30 mm, although corms at maturity average between 15.5 and 18.5 mm in diameter. Corms increase in size when growing conditions provide resources in excess of the amount required for flowering and shrink when resource levels are low. This difference between the amount of resources needed for provisioning the daughter corm for the subsequent growing season and needed for flowering and seed production has been termed the “shortage fund.”



CONCLUSIONS

- The life cycle of *Dichelostemma capitatum* is similar to other geophytes in the Themidaceae.
- Vegetative and sexual reproduction varies according to plant age and size and also appear to be affected by environmental conditions.
- In addition to the morphological differences between *D. capitatum* subsp. *capitatum* and *D. capitatum* subsp. *lacuna-vernalis*, differences between various reproductive parameters are also evident.
- Variation in life cycle parameters among populations of *D. capitatum* may reflect variation in habitat parameters and may be evidence of ecotypic differentiation.