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Bulletin of the Torrey Botanical Club, Vol. 110, No. 3 (Jul. - Sep., 1983), 380-383.

Stable URL:
http://links.jstor.org/sici?sici=0040-9618%28198307%2F09%29110%3A3%3C380%3AOOTRBO%3E2.0.CO%3B2-U

Bulletin of the Torrey Botanical Club is currently published by Torrey Botanical Society.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 110, NO. 3, PP. 380-383 JULY-SEPTEMBER, 1983

Observations on the reproductive biology of *Phytolacca americana* (Phytolaccaceae)

J. J. Armesto, G. P. Cheplick, and M. J. McDonnell[1]

Department of Biological Sciences, Rutgers University, Piscataway, New Jersey 08854

ARMESTO, J. J., G. P. CHEPLICK and M. J. MCDONNELL (Dept. of Biol. Sci., Rutgers University, Piscataway, NJ 08854). Observations on the reproductive biology of *Phytolacca americana* L. (Phytolaccaceae). Bull. Torrey Bot. Club 110: 380-383. 1983.—Fruit production and seed germination were studied in one population of *Phytolacca americana* L. (pokeweed) in the Hutcheson Memorial Forest, New Jersey. Number of fruits per raceme, fruit weight, seed weight, and number of seeds per fruit showed little variation in this population (CV's range: 8-18.8%). Fruit set was 100% for marked racemes, suggesting a high degree of selfing. The number of racemes per individual stem varied from zero on plants less than 40 cm tall to 13 on 2 m tall plants. Plants bearing one raceme or none (<1 m tall) constituted 60% of the population. Germination of unstratified seeds was high (average of 80%), but varied greatly both within (0-100%) as well as between (25-100%) plants.

Key words: fruit set, *Phytolacca americana*, pokeweed, population variability, seed germination.

Phytolacca americana L. is a polycarpic perennial herb common to much of eastern North America (Fernald 1950; Sauer 1952). It is often abundant in open, disturbed habitats, as well as in forest edges and light gaps (Sauer 1952). Its berries are reported to be consumed by 29 bird species (Martin *et al.* 1951) and contain chemicals of pharmacological importance (Burque and Lequesne 1971; Steinmetz 1960). Little information is available, however, on the reproductive biology of this species. Here we report data on fruit production and seed germination for one population of *Phytolacca americana* in central New Jersey. We were interested in quantifying the variability in these reproductive parameters.

Study site and methods. Observations were made on individuals of *Phytolacca americana* (pokeweed) growing in a ca. 20 × 20 m patch at the western edge of the William L. Hutcheson Memorial Forest, located on the Piedmont of New Jersey, 14 km west of New Brunswick. The dominant overstory trees are white oak (*Quercus alba*), black oak (*Q. velutina*) and red oak (*Q. borealis*), with an occasional red maple (*Acer rubrum*). The climate of the area is described by Robichaud and Buell (1978) and soils by Ugolini (1964).

The study site included many clones of pokeweed, but we selected 25 individuals that were more than 2 m apart to reduce the probability that they were the same genetic individual. In September 1981, one raceme on each plant was marked. Thirty-one days later all racemes were collected and raceme length and number of fruits per raceme were recorded. Fruit and seed weight and seed germination of a random subsample of 10 ripe fruits from one raceme from each of 14 of the original 25 plants were determined. The seeds from each fruit were separated from the pulp, counted and weighed. Seeds, separated by plant and berry, were placed into germination boxes and germinated without stratification under a 12 h fluorescent light (intensity ca. 100 ft. c.), 12 h dark regime, and 30/20 C fluctuating temperature. The number of germinated (radicle emerged) seeds was recorded after 9 days. We also tested germination of 381 seeds extracted from bird droppings collected in a nearby field during the fall of 1981.

To determine the variability in number of racemes per plant, we randomly sampled 100 stems of pokeweed in a 150 m long, 2 m wide transect through another section of the Hutcheson Memorial Forest. These stems represented less than 100 different

[1] We are grateful to S. T. A. Pickett, D. White and E. W. Stiles for comments and discussion, and to an anonymous referee for constructive criticism. The senior author acknowledges the support of the HMF Summer Fellowship.

Received for publication December 10, 1982 and in revised form April 21, 1983.

0040-9618/83/03-0380-04$00.60/0

Table 1. Characteristics of racemes, fruits and seeds of *Phytolacca americana* collected on October 20, 1981 in central New Jersey.

	Sample size	Mean	S.D.	Range	C.V. (%)
Raceme length (cm)	25[a]	22.9	3.4	16.0–29.0	14.8
No. fruits/raceme	25[a]	58.0	10.9	27.0–78.0	18.8
No. racemes/plant	100[b]	2.66	3.66	0–16	137.6
Fruit weight (g fresh)	140[c]	0.373	0.063	0.25–0.54	16.9
No. seeds/fruit	140[c]	9.74	0.74	6–12	7.6
Seed weight (g)/fruit	140[c]	0.111	0.009	0.093–0.138	8.0

[a] One raceme/plant.
[b] Number of plants.
[c] Number of fruits.

individuals because some stems belonged to the same clones.

Results and discussion. Flower and fruit production in pokeweed began in late June and continued through summer and fall. During the season of our study all flowers in each marked raceme set fruit. Such high fruit set in natural populations is typical of predominantly autogamous species (Faegri and van der Pijl 1979). The number of fruits on a raceme (Table 1) was related to raceme length ($r = 0.37$; $p < 0.001$), although only 14% of the variability in fruit production was explained by raceme length. We noted that some new flowers formed in the axils of already developed fruits, and since they also set fruit, this may have affected the linearity of the relation between fruit number and raceme length.

Variability measured by coefficients of variation was low for most of the reproductive parameters studied (Table 1). Coefficients of variation for number of seeds per fruit, seed weight, number of fruits per raceme, and fruit weight varied between 8 and 18.8%. The number of seeds per fruit and fresh weight of berries in the population we studied were similar to those reported by Stapanian (1982) for a population in eastern Kansas, indicating that they are relatively conservative traits. The highest variability within our population was in the number of racemes per plant (Table 1), which was a function of stem size (Fig. 1).

The average number of fruiting racemes per plant increased with plant height, to a maximum of 13 (Fig. 1). However, 60% of the plants in our study site were less than 1 m tall, bearing less than one raceme per plant. Plants under 40 cm high bore no racemes. We do not know whether this size distribution varies significantly between years.

Mean percent germination of pokeweed seeds was high for most plants (Table 2), with an average of 80%. This figure is slightly lower than that reported by Farmer and Hall (1970) also for unstratified seeds. These authors point out the importance of interplant variability in pokeweed seed germination. Because we kept seeds from each plant and fruit separate, we were able to determine the amount of intra- and inter-plant variability.

In our population, variability in the germination of seeds collected from 25 different individuals varied between 25 and 99% (Table 2). This variation was not related to mean seed weight per plant (Table 2). Variability in mean percent germination of seeds from a single plant was also high, as indicated by the coefficients of variation which ranged between 3 and 86% of the mean. Thus, seeds from different berries on the same raceme have different probabilities of germination. Possibly, this is related to different stages of maturation of the seeds, since pokeweed fruits ripen over a long period of time. Because of the indeterminate nature of the pokeweed raceme, ripe (purple color) fruits collected at one time may come from either early or late flowers, and thus exhibit differences in development. It is interesting to note that germination was not statistically related to seed weight. Accordingly, seed germinability appears to be more a function of physiological conditions than the

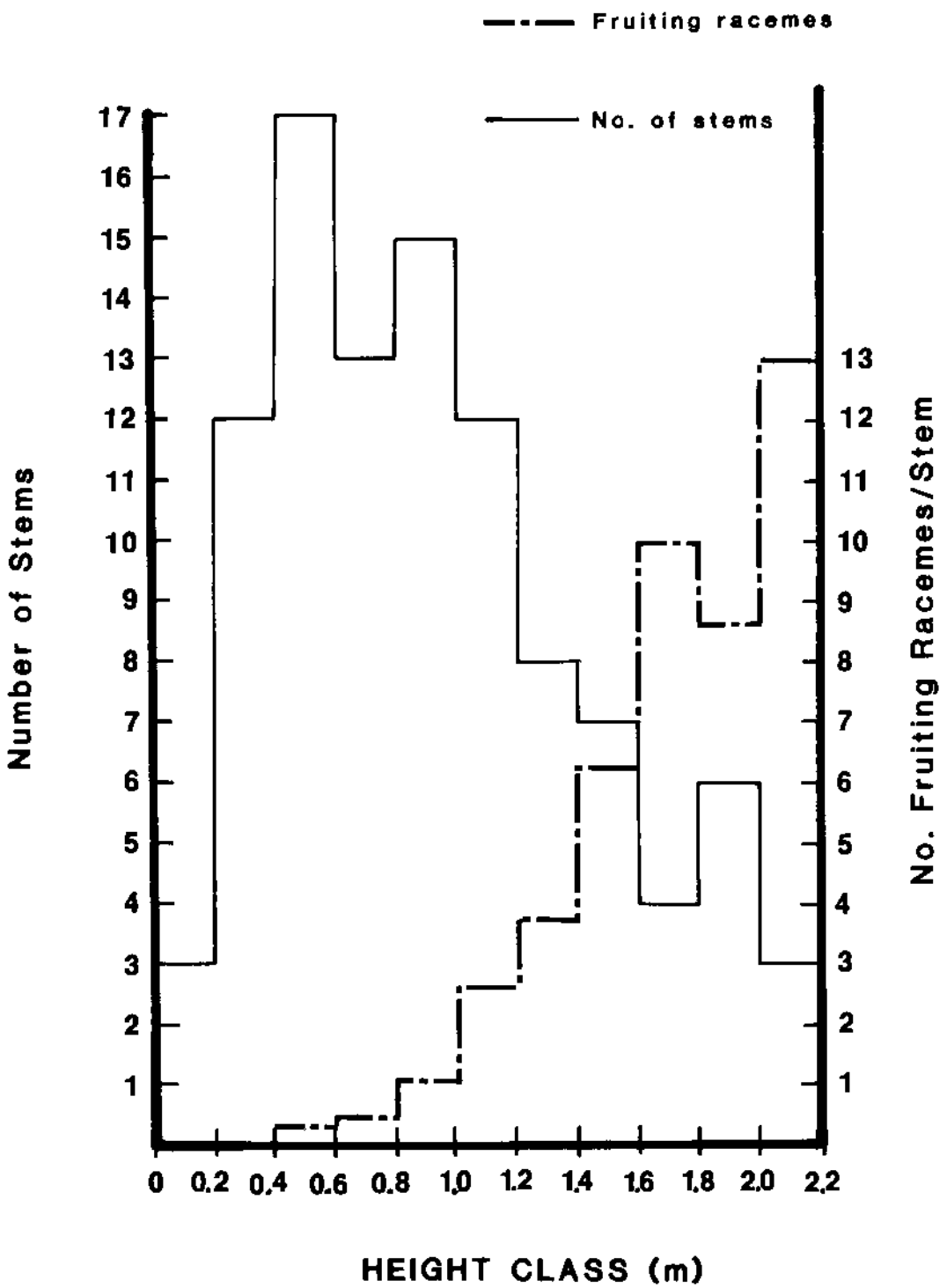

Fig. 1. Frequency distribution of number of stems per height class and mean number of fruiting racemes per stem in pokeweed. The abscissa is the lower limit of each height class interval.

Table 2. Between and within plant variability in seed germination in *Phytolacca americana*.

Plant no.	Mean % germination[a]	S.D.	C.V. (%)[b]	Mean seed wt (g) per 10 seeds
1	83.7	24.6	29.4	0.098
2	35.5	15.2	42.9	0.110
3	39.8	20.4	51.2	0.111
4	98.0	6.3	6.4	0.100
5	97.0	4.8	5.0	0.106
6	98.0	4.2	4.3	0.099
7	96.9	5.0	5.2	0.117
8	99.1	2.9	2.9	0.088
9	93.9	8.5	9.0	0.097
10	87.3	11.2	12.8	0.094
11	97.1	4.7	4.8	0.106
12	24.7	21.3	86.3	0.109
13	98.0	4.2	4.3	0.105
14	80.3	33.1	41.2	0.133

[a] Percent germination is the mean of 10 replicates of 10 seeds each, and each replicate is one berry taken from a single raceme.
[b] Within plant variability.

amount of stored resources. The variability between plants, on the other hand, may be due to factors such as differences in genotype, availability of resources, and/or age of the plants.

Based on an average of 58 berries per raceme (Table 1), one pokeweed shoot may bear as many as 754 fruits, with an average of 154, although only a proportion of these fruits are ripe at any one time. Fruit displays of this size attract many migrant and resident birds which consume pokeberries (Thompson and Willson 1979). Of 381 seeds extracted from bird droppings, 84% germinated after 8 days, a value comparable to that reported above for intact seeds. This indicates that seeds remain viable after passage through a bird's digestive tract, and, therefore, frugivorous birds may constitute effective dispersal agents of pokeweed. These characteristics, namely, a high fruit set, high seed germinability, and the possibility of birds acting as dispersal agents suggest that reproduction by seed, as compared to vegetative propagation, has a great importance in the life-history of this species, as a means of colonizing transient habitats.

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