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True Breeding Red-Budded Mountain Laurel

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Selected cultivars of mountain laurel, *Kalmia latifolia* L., have been known for over 100 years. Yet, because cuttings are difficult to root, none of these selections has been widely distributed to the public. Our breeding results indicate that some of the more striking flower color types are simply inherited and could be grown true to type from seed of controlled crosses. However, emasculation and pollination of individual flowers by hand is tedious and time-consuming. An inexpensive method of producing hybrid seed in quantity is needed for commercial production of laurel selections. Some nurserymen sow open-pollinated seed of selected plants but segregation occurs in the seedlings and the desired types can be identified only after they flower. The new method must give seedlings that are notably homogeneous within each seed lot, and whose flower types are known in advance.

The results of controlled crosses made by hand pollination were sufficiently encouraging to suggest the use of bees to pollinate flowers of caged plants for larger scale production of hybrid seed. The method was used to produce red-budded mountain laurel and the pure white sheep laurel, *Kalmia angustifolia* L. f. *candida* Fern., from seed. It is described herein together with the results of an interspecific cross and some suggestions for the production of other selections.

Materials and Methods

Our earlier work with hand pollinations in mountain laurel and sheep laurel demonstrated that seed set from self-pollination was only some 15% of that from cross-pollination (Jaynes 1968b). Thus with two plants of the same species in the same cage it was expected that outcrossing would occur in preference to selfing. In 1969 and 1970, 13 cages of single and paired plants were used with and without honey bees (*Apis* spp.) and bumble bees (*Bombus* spp.) to determine if the bees were effective pollinators when confined with laurel.

Cube-shaped wooden frames, 3 feet on a side, were made and covered on 5 sides with aluminum window screening (Figure 1). The plants used were all field grown and within 10 feet of other flowering plants of the same species. When necessary, selections were moved next to each other prior to caging. Selections were caged before flower buds opened and the lower edge of the screen covered with 2 inches of soil. When the flowers began to open, one or two bees were introduced under the screen by temporarily removing some of the soil. Cages were checked every two days and if the bees were found to be dead fresh bees were introduced. Bees were taken from plants other than *Kalmia* and were caught in glass

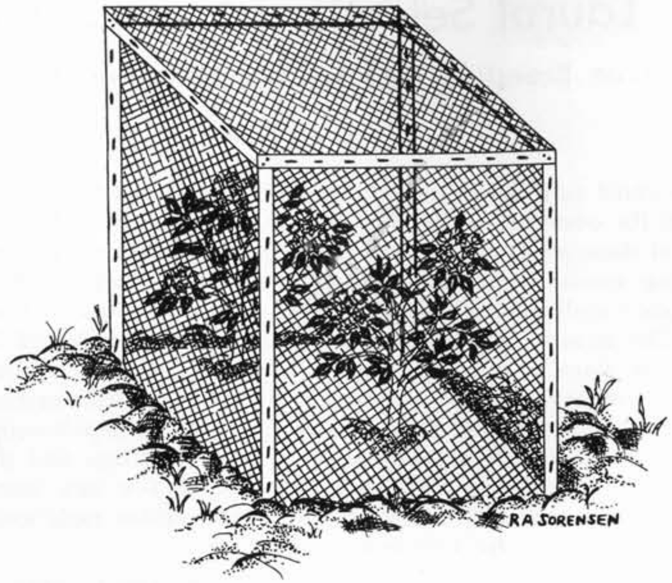

Figure 1. Screened cage used over laurel plants to exclude pollinating insects and to confine introduced bees.

jars. The second year (1970) all bees were rinsed briefly in lukewarm water to remove loose pollen prior to introduction into the cage. Our best source of bumble bees was from flowers of weigelia.

The cages were removed after all the flowers had faded, and the flowers which had been open were counted. Capsules were counted after harvesting in the fall. The amount of seed produced varied. Where little was formed it was all counted and estimates were made of the more productive crosses by counting seeds in at least 20 representative capsules.

Results and Discussion

Results from the caging experiments involving 12 plants (A-L) are presented in Tables 1 and 2. Cages with 1 or 2 plants, but with no bees introduced, produced few or no capsules (0-0.6%) and little or no seed. Thus self- or cross-pollination does not normally occur when mountain laurel is screened from insect vectors. Either the anthers, held under considerable tension in pockets of the corolla, are not released at the proper time or, if released, the pollen does not land on the stigmas.

Although self-pollination of mountain laurel by hand results in little or no seed production, the single plants caged with bees each produced appreciable amounts of seed. Hand self-pollination may be less efficient because flowers are only pollinated once while bees visit most of the flowers many times over a period of several days. It is suspected that timing is more critical with self-pollinations than with cross-pollination.

Table 1. Seed yield from caged mountain laurel plants with and without bees

Cage no. and year	Plant identification	Bees	No. of flowers	% Forming capsules	Seeds per capsule	Total no. seed
1-69	A	0	816	0.6	24.0	120
1-70	A	Bombus	151	82.1	116.0	14,400
2-69	B	Apis	115	8.7	31.4	314
2-70	B	0	45	0	0	0
3-69	C	Apis	953	1.9	53.3	959
	D		822	31.4	60.2	15,500
3 70	I	Bombus	539	67.8	99.7	36,400
	J		364	92.3	100.0	33,600
4-69	E	0	886	0.9	11.8	94
	F		47	0	0	0
4-70	E	Bombus	24	87.5	67.4	1,420
	F		98	91.8	221.2	19,900
5-69	G	Bombus	858	58.7	66.8	33,700
	H		1,200	95.6	28.0	32,100
5-70	G	0	40	0	0	0
	H		36	0	0	0
8-70	K*	Bombus	315	40.3	21.1	2,680
	L*		387	49.4	11.3	2,150

*Red-budded mountain laurel. Seed yield would probably have been higher but reduction in pollen production was observed.

The two cages in which honey bees were used demonstrated that honey bees are effective pollinators of single and paired mountain laurel plants but that they are not as good as bumble bees. Their greatest handicap is an inability to survive more than a day or two away from the hive. Bumble bees on the other hand can survive in the cages for the entire flowering period of approximately two weeks. However, they survive for only a few days in cages with just a few flowers open. Supplemental food (sugar-water) should probably be made available to them under such circumstances.

Table 2. Seed yield from an interspecific cross and from white flowering sheep laurel—both pollinated by caged bumble bees

Cage No. and year	Plant identification	No. of flowers	% Forming capsules	Seeds per capsule	Total no. seed
6-70	*K. a.* f. *candida**	1,573	45.2	5.8	4,100
	K. latifolia	366	77.0	75.0	21,200
7-70	*K. a.* f. *candida**	2,907	62.9	25.0	45,800
	K. a. f. *candida**	3,157	15.8	16.2	8,100

*Three different clones of *Kalmia angustifolia* f. *candida* were used.

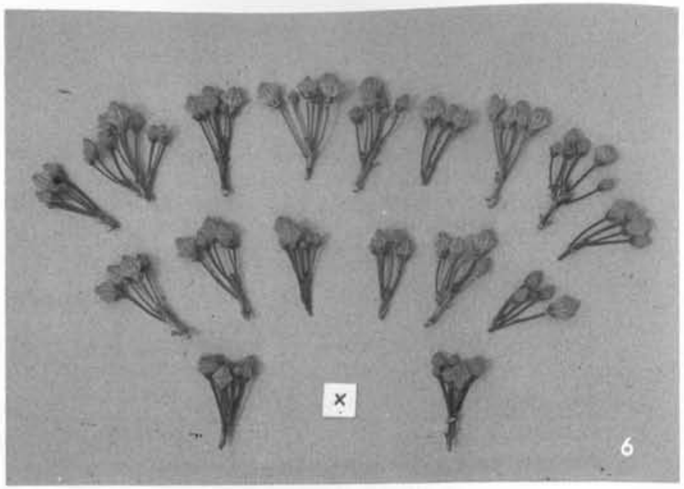

Fig. 2, 3, & 4. Red-budded mountain laurel; three different plants.

Fig. 5. The common mountain laurel. Buds on this plant are pinker than most found in the wild.

Fig. 6. Bud clusters from two parent plants, *lower row,* and 15 seedling offspring, all with red-bud color.

Fig. 7. Sheep laurel, selected for rich flower color and good form. Several years old and 16 inches tall.

Fig. 8. White-flowered sheep laurel.

Table 3. Segregation of seedlings from crosses among red-bud clones

Crosses of red-bud clones*	Flower color of seedlings Normal	Red-bud
C x A	0	18
C x B	0	18
D x B	0	19
A x E	0	8
A x F	0	1
Total	0	64

*All of the parental clones were obtained from Weston Nurseries, Hopkinton, Massachusetts.

Small plants with large numbers of flowers appear to set fewer capsules and have fewer seeds per capsule than plants with smaller numbers of flowers. Recently transplanted plants also tend to set less seed.

Red-budded mountain laurel

Mountain laurel selections with red buds are striking in appearance (Figures 2-4). Sixty-four seedlings have flowered from controlled crosses of red-bud clones and all of these have the red-bud flower color (Table 3). These results suggest that if both parents are red-buds then all the progeny will also be red-bud. Two red-bud clones confined with bees should be capable of producing a large quantity of seed from which all seedlings would be red-bud. Preliminary data indicate that the red-bud trait is recessive in crosses with plants having light-colored buds, but more of these progeny have to flower to determine the number of genes involved.

Relatively low seed set was observed between the two caged red-budded mountain laurel (Cage 8-70, Table 1). This was probably due to low pollen viability, which has been observed among some of these intensely selected laurel. In addition, these two plants were siblings, thus inbreeding may also have contributed to the light seed set. Seed set on the white-flowered sheep laurel in cage 7-70 (Table 2) might have been depressed for the same reasons. Because of possible low pollen viability or even incompatibility between any two plants, more than two clones could be used in a cage to insure cross-pollination and high fertility. To maximize vigor, the genetic backgrounds of selections should be as unrelated as possible; the use of siblings as noted may lead to inbreeding depression.

Propagation of the red-budded form: The production of red-budded mountain laurel seed in quantity, and our evidence that it breeds true, means that seedlings can now be marketed as a known color form before the flowers open. It also means that the red-bud form could probably be rooted from cuttings, for, instead of taking cuttings from the older flowering plants that are difficult to root, cuttings can be taken from the 1- to 2-year-old seedlings. Propagators have long been aware that young seedlings will root more readily than older flowering plants, but propagators of mountain laurel could not take advantage of this fact because the seedlings were of unknown flower color.

White-flowering sheep laurel

The presence of pigment is determined by a single dominant gene in sheep laurel (Jaynes 1971). Thus the true-breeding recessive is white-flowered: such seedlings can be distinguished by their green stems, in contrast to normal seedlings which have reddish stems. A caged pair of white-flowering plants cross-pollinated by bees should produce only green-stemmed seedlings unless pollen from normal plants is introduced by wind or other means. In the latter case some of the seedlings would have reddish stems.

Of 227 seedlings (110 and 117 respectively) grown from the pair of white-flowering sheep laurel (cage 7-70, Table 2) which had been crossed by bumble bees, none had reddish stems. This is evidence that sheep laurel, like mountain laurel, is not wind pollinated.

Sheep laurel crossed by mountain laurel

Different species of laurel are difficult to cross with one another (Jaynes 1968a). For instance, no seed was produced from 850 emasculated mountain laurel flowers pollinated with sheep laurel pollen. Of the reciprocal cross, in which 1,300 flowers were used, 18% of the flowers produced capsules containing some viable seed, and most of these seeds were formed on a clone of the white-flowered sheep laurel that was used as the female parent.

By caging a mountain laurel with a white-flowered sheep laurel plant and introducing bees it is possible to obtain answers to several questions:

1. Will mountain laurel self-fertilize, remain sterile, or be fertilized by sheep laurel pollen? The last possibility would contradict the negative results obtained from hand pollinations as well as evidence that sheep laurel pollen does not grow down the style of mountain laurel (Jaynes 1968a).

2. Will sheep laurel self-fertilize or remain sterile, or is it fertilized by the mountain laurel pollen? Crossing by normal sheep laurel from outside the cage would be detected if the resulting seed produced any seedlings with reddish stems. Interspecific hybrids are morphologically distinct from seedlings of either species.

A white-flowered sheep laurel and a mountain laurel plant were caged together (6-70, Table 2) and seed was set on both plants. This seed was sown, and from one lot of 340 seeds from the sheep laurel, 51 viable seedlings resulted. All of these were interspecific hybrids with mountain laurel except for two, which were pure sheep laurel, and apparently resulted from self-pollination (they had green, not reddish, stems). Thus, the pollen of mountain laurel was markedly more effective in fertilizing ovules of this white-flowering sheep laurel than was pollen from the sheep laurel plant itself. All of the seedlings from the mountain laurel plant were typical of the species and presumably resulted from self-pollination.

This caging of the two species is a much more effective way of crossing sheep laurel and mountain laurel than the hand-pollination technique. Emasculation always injures some of the pistils and pollen is normally applied only once, whereas, the bees, as already pointed out, visit each flower many times. Furthermore, to emasculate the 1,573 flowers on the caged sheep laurel would have involved two to three man-days of work.

The use of bees to make crosses or to self-pollinate caged plants might well be useful with other species. Certainly their effectiveness with the closely related rhododendrons should be tested.

Summary

Bumble bees are effective pollinators of caged mountain laurel and sheep laurel plants. Laurel seed that will breed true can be produced in quantity by selecting the proper parent plants. Seed from crosses of different clones of red-budded mountain laurel produces seedlings which all have red buds. White-flowering sheep laurel will also come true from seed. As more is learned about the inheritance of other characteristics of laurel, other possibilities for growing selections which will come true from seed will arise. The scheme presented for producing seed allows for cuttings to be taken from young, unflowered (juvenile) mountain laurel seedlings of known flower type at a time when they should root readily. In addition to crosses within species, interspecific hybridization of sheep laurel and mountain laurel was demonstrated to be efficiently performed by bumble bees in a cage.

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