Title: Pollinator diversity and efficiency in southeastern blueberries

Report type: Progress report

Grant Code: 2010-10

Proposal type: Research

Name(s), mailing and email address(s) of principal investigators

David R. Tarpy	Hannah J. Burrack	Shelley Rogers
Principle Investigator	Co Principle Investigator	Co Principle Investigator
Associate Professor and Extension Apiculturist	Assistant Professor and Extension Specialist	Graduate Research Assistant
david_tarpy@ncsu.edu	hannah_burrack@ncsu.edu	srrogers@ncsu.edu

Department of Entomology, North Carolina State University
Raleigh, NC 27695-7613

Objectives

1. Identify pollinator diversity and abundance in southeastern blueberries
2. Determine efficiency of pollinator species present in blueberries
3. Determine the impact of cultural practices on pollinator abundance, diversity, and efficiency

Justification

Southeastern states contribute a substantial proportion of blueberry production in the US (approximately 30%), with the largest acreages in Georgia and North Carolina. Growers in these two states, however, differ significantly in their production practices. In Georgia, there are approximately 9,500 acres, with roughly 90% being rabbiteye (*V. ashei*) varieties with the remaining acreage southern highbush (*Vaccinium corymbusum*) varieties. By contrast, in North Carolina, there are approximately 6,000 acres, with roughly 75% being southern highbush and 25% rabbiteye. These differences in productions systems are important when considering pollination. Blueberry pollinators have been previously studied in highbush systems in Michigan and the Pacific northwest, as well as in rabbiteye varieties (specifically 'Climax', 'Tifblue', and 'Premier') in Georgia. However, there has been little to no work on the southern highbush varieties grown elsewhere in the southeast. Given the critical importance of adequate pollination for optimal and reliable blueberry production, understanding the pollination ecology of NC blueberry systems is of fundamental interest.

Methods

This work was conducted at seven locations spanning North Carolina in 2010. Sites were selected to represent geographical and production diversity, and they included locations in the Coastal Plain, Piedmont, and Mountain regions of the state with organic and conventional farms (Figure 1). Varieties present at each site varied significantly, and data were collected on southern high bush (SHB), northern high bush (NHB), and rabbiteye (RE) plants among all locations. Each site was visited at least twice: once to collect pollinator-diversity data during bloom and conduct pollinator efficacy experiments, and once to collect fruit samples from cages. Two of our sites in southeastern NC were visited multiple times.

We conducted three activities at each site visit. (1) To assess pollinator diversity, we conducted timed transect walks hourly from 9am through 4pm. All pollinators visiting flowers per transect were counted and identified to species (when possible). One transect at each site was established on either an outer or inner row in the field. (2) Along nearby transects, we placed pan traps to collect pollinators present in the planting. One pan trap transect was placed in an outer row, one in an inner row, and one in a non-crop portion of the field. These pan traps were left out all day and collected at the end of each visit. (3) We measured single-visit pollination efficiency by conducting small cage experiments. We excluded pollinators from one branch on a minimum of five plants of the same variety per site by placing large cages over the branch prior to bloom. During bloom, we returned to the site, removed the large cage, and waited for pollinators to visit exposed, virgin flowers. After a pollinator visited a flower, the flower was labeled (by pollinator species) and enclosed in a small bag to prevent additional pollinator visits. Closed controls (i.e., flowers never exposed to pollinators) and open controls (i.e., flower never caged) were included at each location.

Results

Objective 1: Pollinator diversity and abundance

Nine distinct families of hymenopteran pollinators (i.e., bees and wasps) were observed at blueberry flowers. A greater number of these same species were collected in pan-trap samples (Table 1), which are still being processed. Pollinator diversity varied among sites, most markedly with respect to geographic region but also within sites for which there were multiple observation dates (Figures 2 and 3). All pollinators were more common at RE than at SHB flowers (Figure 4). Interestingly, variation in pollinator visits was observed among RE varieties, specifically between 'Premier' and other varieties. Honey bees visited 'Premier' flowers more frequently than other RE varieties (Figure 5).

Objective 2: Pollinator efficiency

Single-visit efficiency was measured in two ways, fruit set (the percentage of possible total fruit that developed), seed set (the number viable seeds per fruit), and fruit volume. Fruit volume and seed set are significantly correlated, and seed set was determined to be a more accurate measure of pollination efficiency (since fertilization is required to produce a viable seed). All three types of blueberries (SBH, NHB, and RE) benefited from cross pollination (Figure 6a). Fruit set in SHB varieties approached open controls following single visits from bumble bee queens, honey bees, and small native bees (Figure 6b). A single visit to a RE flower never resulted in fruit set near or equal to that of the open controls, but single visits of bumble bees resulted in the greatest fruit set (Figure 6c). Both fruit volume and seed set were correlated to fruit set (Figure 7; data from 'Oneal' fruit only). In subsequent years, we will therefore consider seed set to be the primary response variable.

Objective 3: Impact of cultural practices on pollinators
In 2010, we collected data at organic, abandoned, and conventional plantings. These fields also differed greatly in scale, ranging from over 150 acres to under 1 acre. Clear trends have not emerged from the 2010 data, but we will combine data sets from 2010 and 2011 to address these questions.

Conclusions

The pollination ecology of NC blueberry systems is diverse and significantly different from analogous systems in GA, MI, and the PNW. RE varieties attract different types and greater numbers of pollinators compared to NHB and SHB varieties. Since NC blueberry systems are predominantly SHB, understanding these differences may be important for production. SHB seed and fruit set were increased most significantly by honey bees, bumble bee queens, and small native bees, thus augmenting or otherwise promoting these species may be favorable for increased production. Additional studies on the impact of cultural practices on pollinators are therefore warranted in order to maximize pollination efficacy in NC blueberry systems.

Impact Statement

Blueberries account for over $51M in annual economic value in the state's agricultural economy. Approximately 90% of this production value relies on bees for effective seed and fruit set. Optimizing pollination efficacy can therefore promote a stable, reliable pollinator community for blueberry production.

Citation(s) for any publications arising from the project

None at this time.

Table 1. Average number of pollinators observed per transect by geographic region (Coast = 3 sites, Piedmont = 2 sites, Mountain = 2 sites).

Pollinator	**Count (Average number of bees per 1000 ft transect)**		
	Coast	**Piedmont**	**Mountain**
Apis mellifera (honey bee)	36.0	46.7	0.8
Habropoda laboriosa (southeastern blueberry bee)	11.4	11.7	0
Xylocopa virginica (carpenter bee)	2.3	23.7	0.6
Andrenidae, Halictidae, Colletidae, Megachilidae (small native bees)	1.6	0.2	16.0
Bombus spp. (bumble bees)	0.8	7.9	12.4
Megachilidae (one species restricted to single site)	0	0	23.5

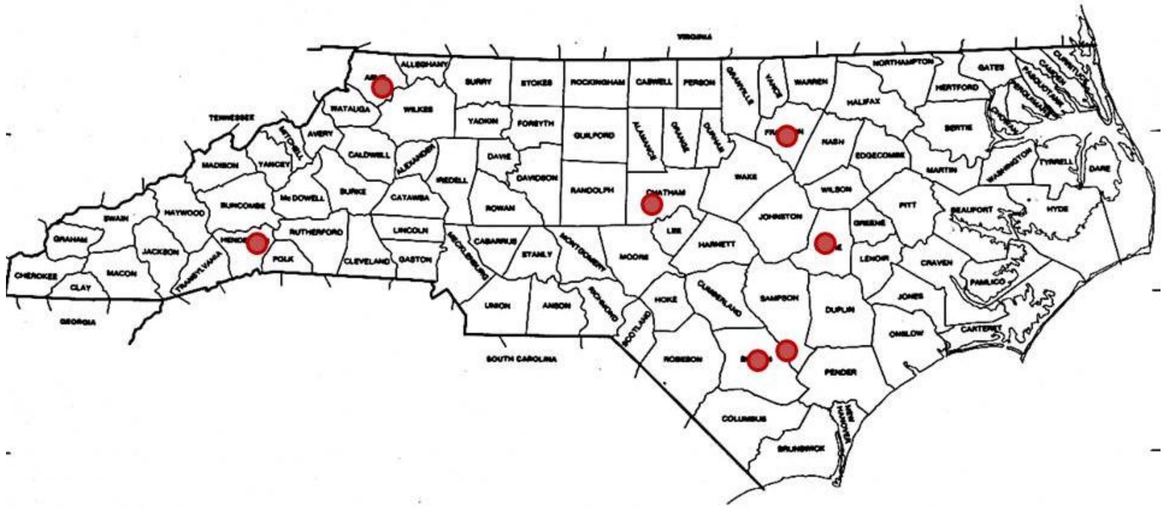

Figure 1. Blueberry pollination sampling sites, 2010.

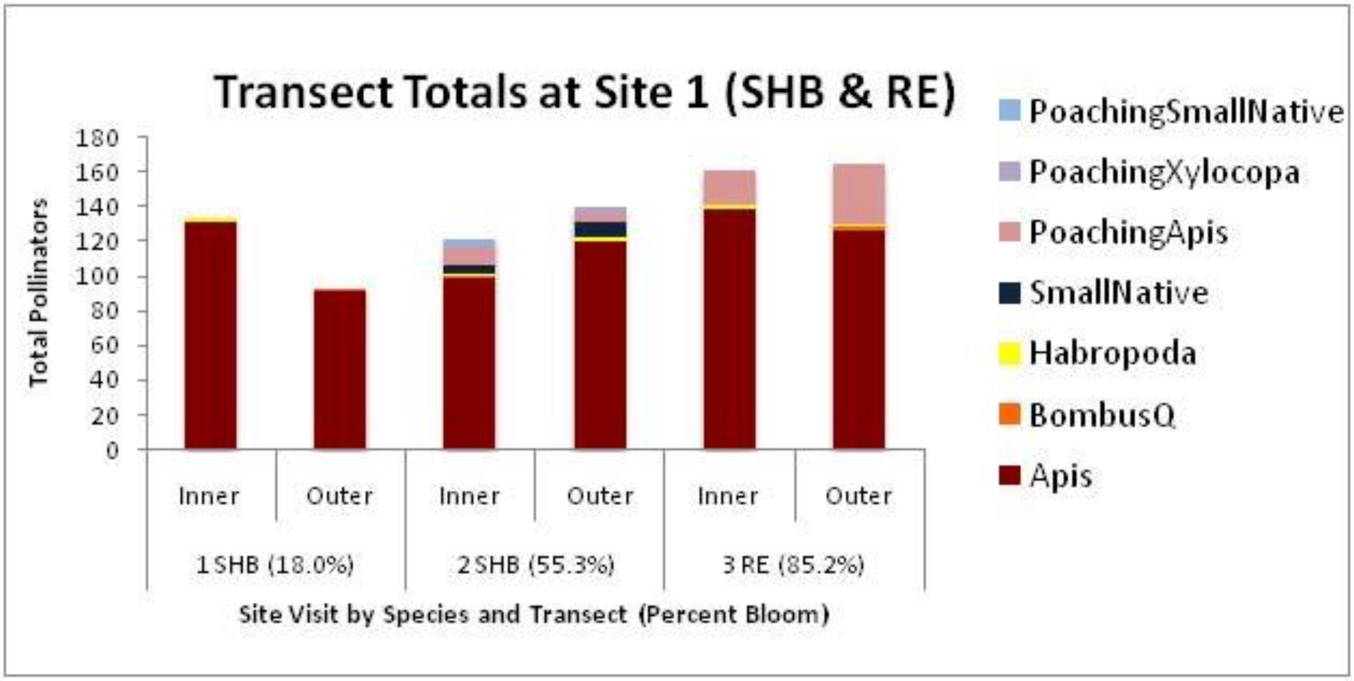

Figure 2. Total pollinators observed per transect. Site 1 was heavily stocked with honey bees, which engaged in poaching behavior more frequently as bloom progressed.

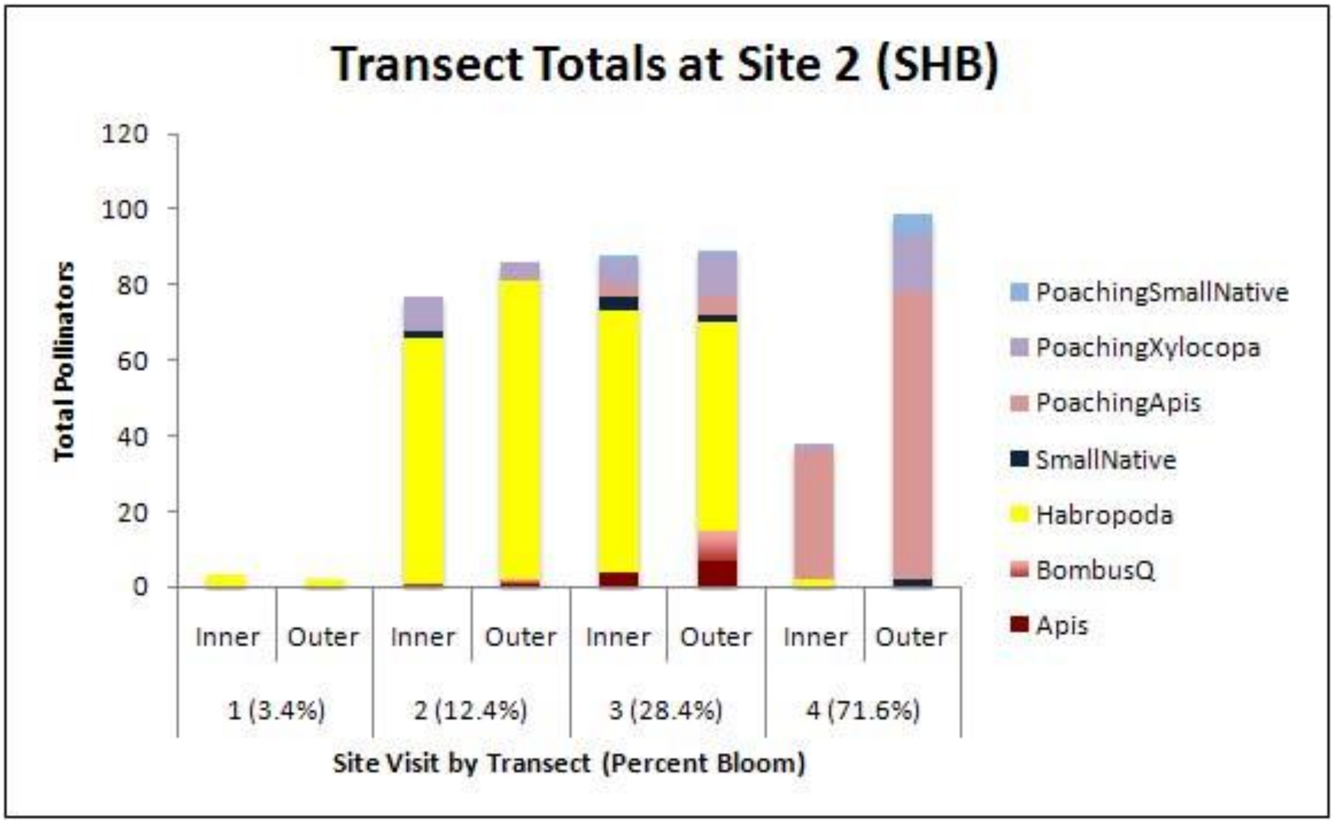

Figure 3. Site 2 was stocked with bumble bees, but the most common foragers were southeastern blueberry bees (*Habropoda laboriosa*). Honey bees, both legitimately forging and poaching, increased later in bloom.

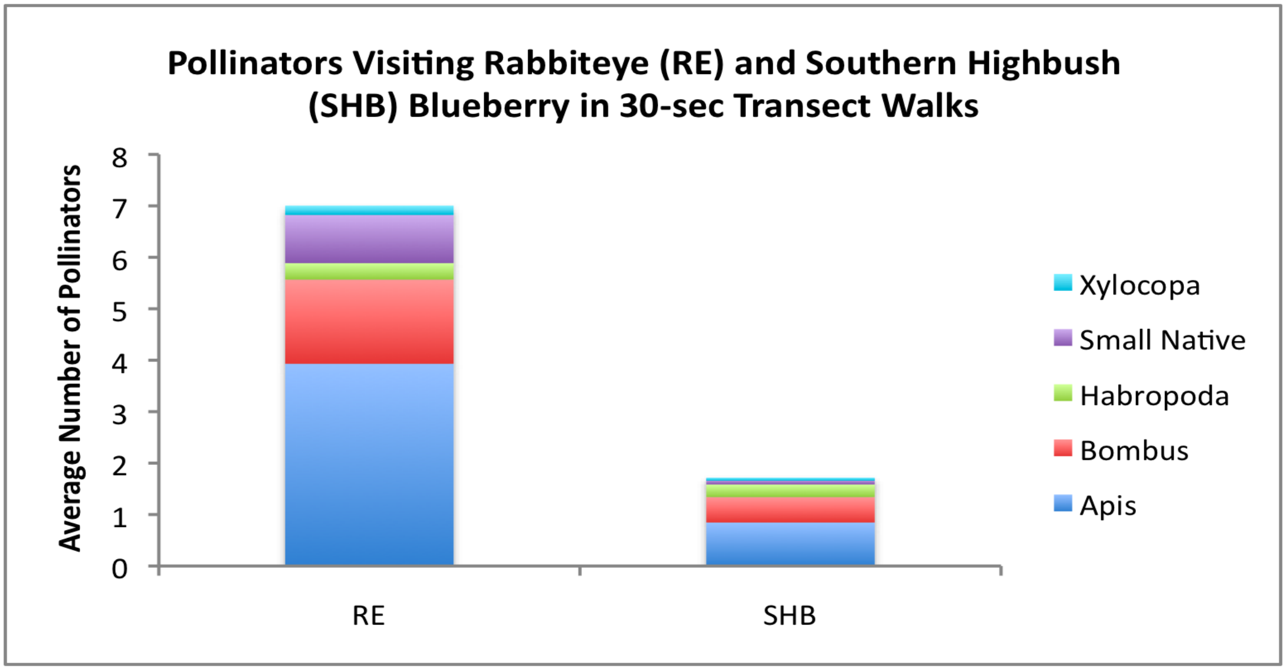

Figure 4. Pollinators visiting RE and SHB flowers during per transect. Average over all sites.

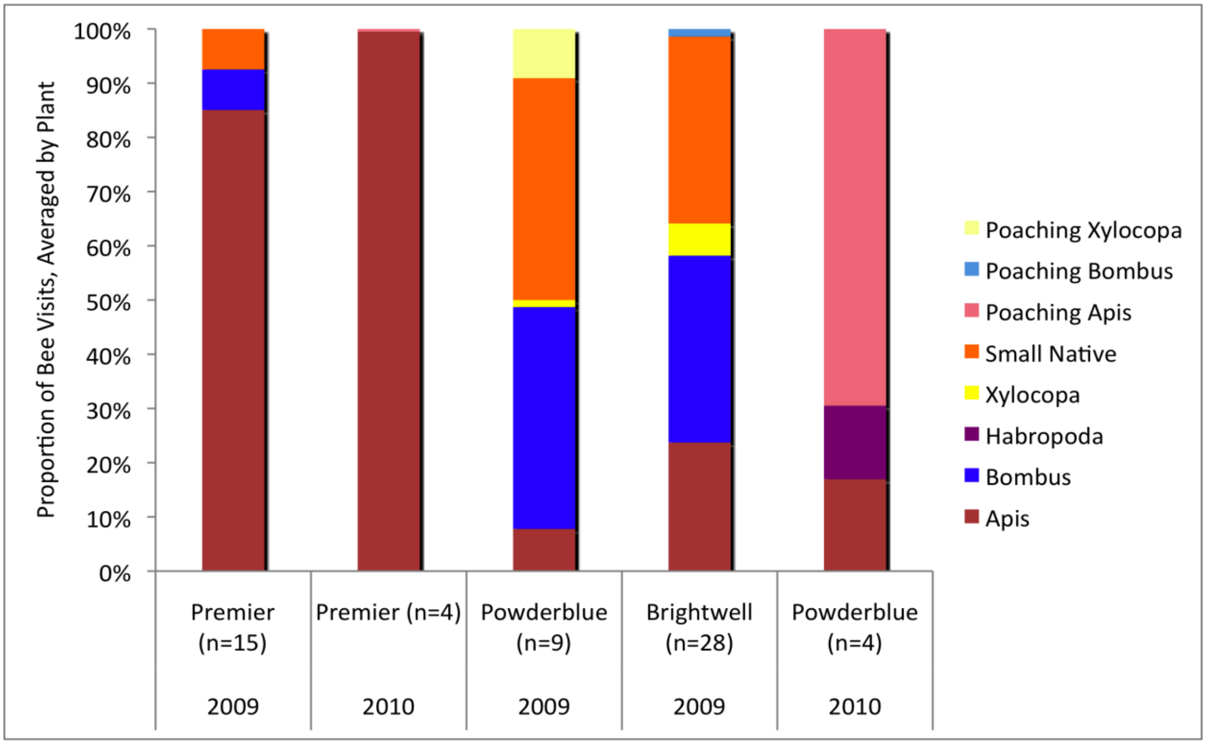

Figure 5. Proportion of bee visits to adjacent rabbiteye plants by pollinator group.

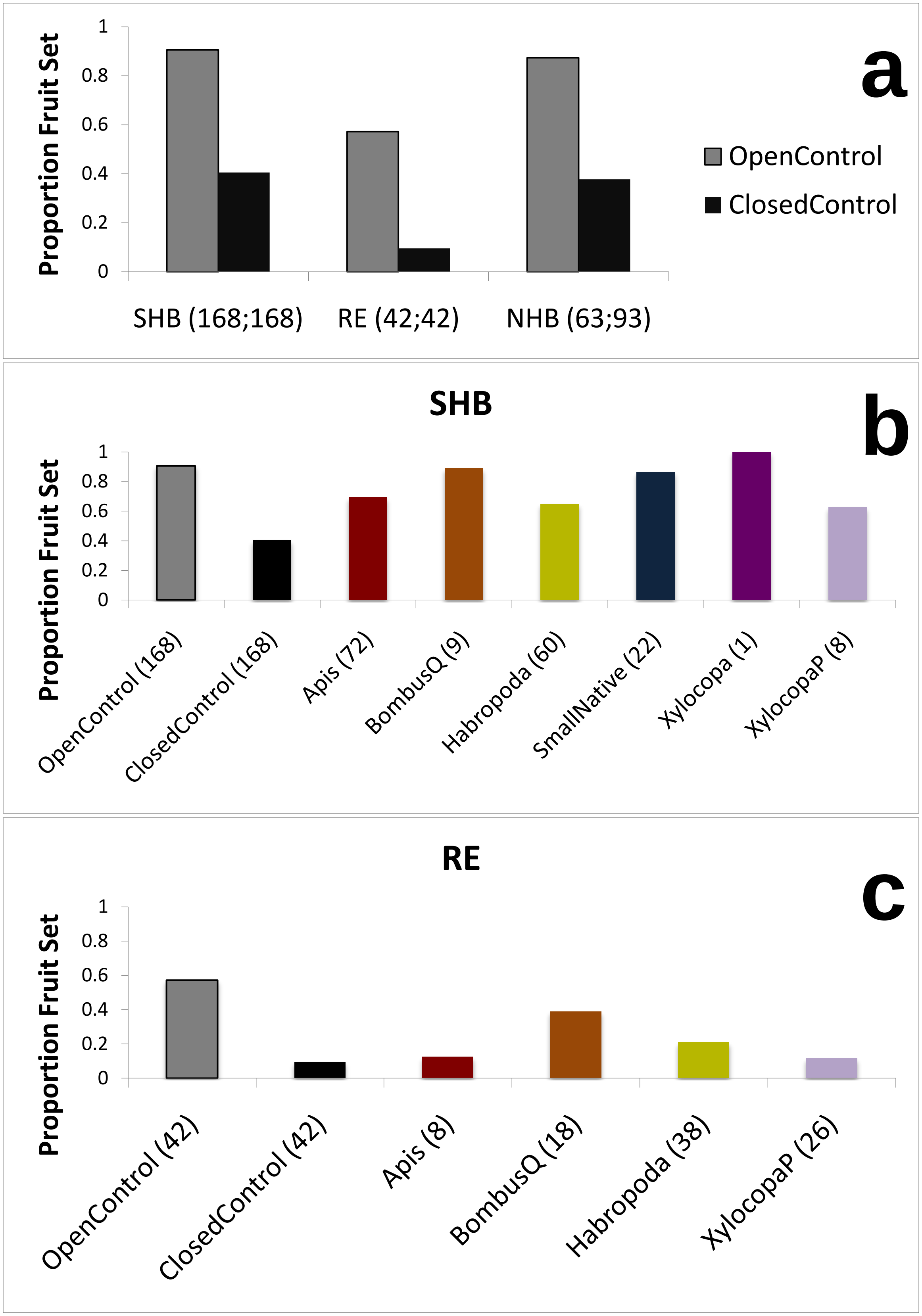

Figure 6. Proportion fruit set (n) from open and closed controls and single pollinator visits.

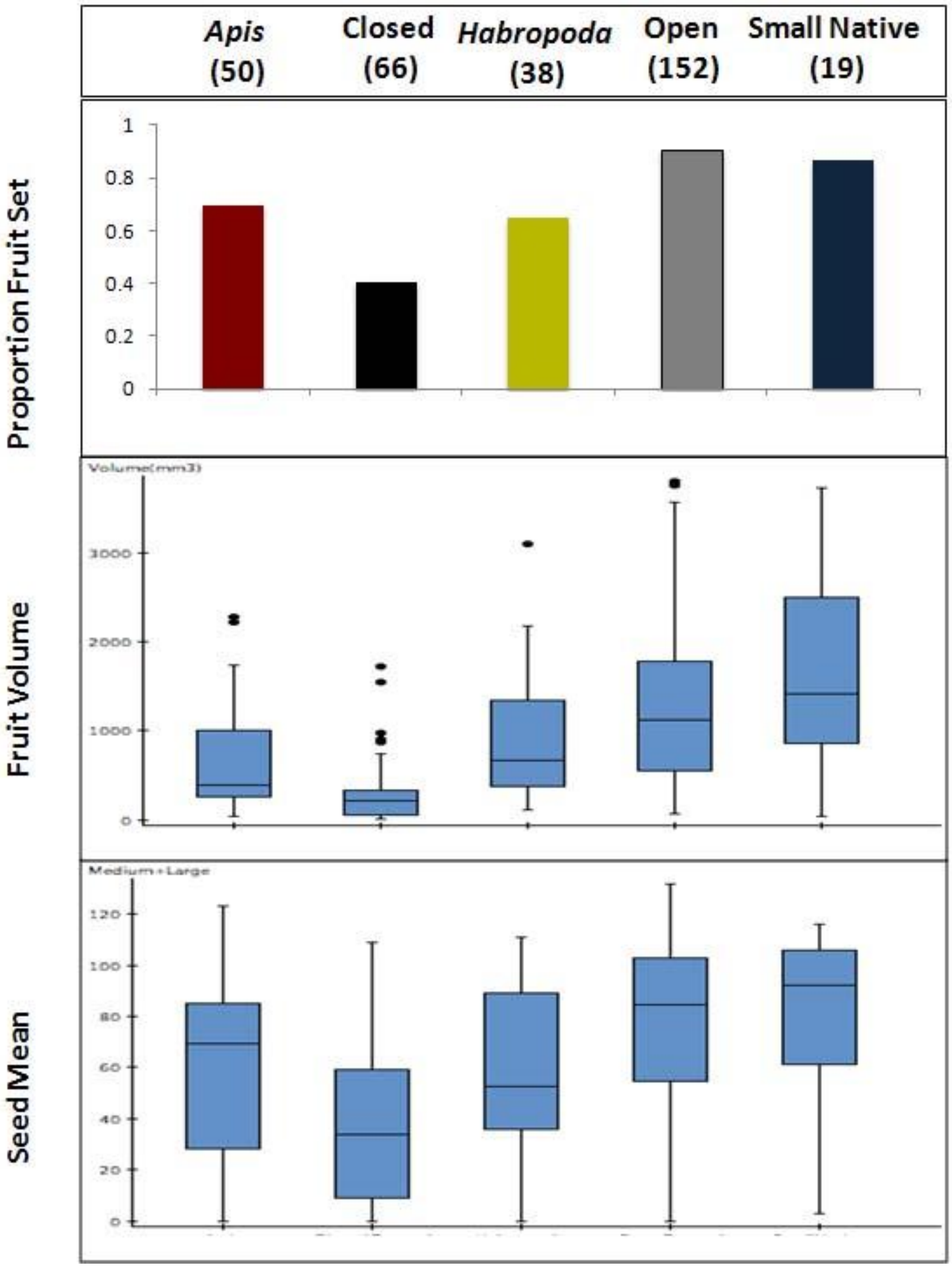

Figure 7. Proportion fruit set, fruit volume, and number of viable seeds for Oneal (SHB) fruit collected from all locations with this variety present. Number of observations per pollinator in parentheses.