

CASE STUDIES ON CONSERVATION OF POLLINATION SERVICES AS A COMPONENT OF AGRICULTURAL BIOLOGICAL DIVERSITY

TITLE:

Importance of squash bees (*Peponapis* & *Xenoglossa*) as pollinators of domestic *Cucurbita* in the Americas: SPAS (Squash Pollinators of the Americas Survey)

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Squash pollinators of the Americas survey-USA, Mex



## Overview

A persuasive case study of wild pollinator dynamics is needed, that spans geographic regions and cannot be dismissed as due to local anomalies. Given the methodological problems of sampling whole pollinator communities, an alternative methodology has been developed and is being tested for a distinctive, but widespread pollination system in the Americas, involving squashes and squash bees.

Sampling design is guided by several considerations and principles:

- Ease of data interpretability is key; the goal is maximum data return for modest effort.
- Strict uniformity and consistency is needed across all sites, to facilitate analysis and easy comparison.
- Data is maintained on simple Excel spreadsheets
- Time and labor allocation is minimized: each site needs to be visited at least once to gather bee, bloom and plant data.
- The task of data analysis can be decentralized; groups of nearby collaborators can coordinate the research and writing of a manuscript for their "region".

In the past six months, SPAS (Squash Pollinators of the Americas Survey) have surveyed cultivated squashes and pumpkins at 20 sites in 11 states (including Mexico). Thus far, *Peponapis pruinosa* has been present at all but one site, ranging in abundance from 10-120 bees per 100 flowers censused. The smallest patch had 40 squash plants, the largest had 90,000. The latter hosts an estimated 1 million *Peponapis* bees, and the grower currently spends \$25,000 annually to rent honey bees for what is probably superfluous pollination service.

## I. Background/Problem statement:

Many proponents of pollinator conservation argue that unmanaged bee populations have a critical role to play in the provision of ecosystem services; a role that cannot routinely be filled by domesticated bees such as honeybees. But data showing that wild bee populations are in decline, or in some way merit concern and conservation efforts, are almost nonexistent. Wild bee communities show tremendous spatial and temporal variation, and there is a lack of sound baseline data against which to compare trends. The intensity of spatiotemporal replication that would be required to document declines in whole pollinator communities is most likely beyond the resources of any research organization, anywhere (see special issue of Conservation Ecology 5:1). Until methodological problems of permitting valid "Before and After Control Interactions" analyses for pollinator declines- characterized by large variation and weak baseline data- are worked out, whole pollinator fauna surveys may be misleading or unhelpful.

## II. Objectives/Purpose of the Activities:

A persuasive case study of wild pollinator dynamics is needed, that spans geographic regions and cannot be dismissed as due to local anomalies. Given the methodological problems of sampling whole pollinator communities, an alternative methodology has been developed and is being tested for a distinctive, but widespread pollination system in the Americas, involving squashes and squash bees. Sampling methodology is very time-efficient, and a network of collaborators are sharing their experiences in the use of the methodology.

## III. Details of the case study and the approach taken:

If pollination biologists are going to advocate unmanaged native bees for crop pollination, then we need a persuasive case study that cannot be dismissed as some local anomaly or peculiar circumstance. Probably the single most promising system in the Americas involves bees of the genera *Peponapis* and *Xenoglossa* for pollination of cultivated squashes, pumpkins and gourds (*Cucurbita*). Both genera are native, non-social, ground-nesting bees. All species are specialists that forage solely at species of *Cucurbita*. No pollinator exceeds female *Peponapis pruinosa* in effectively pollinating zucchini, and since their daily flight and foraging activity precedes that of other bees, like honey bees, they can satisfy pollination needs daily within a few hours after sunrise. The genus *Peponapis* in particular is widespread, with representative species extending the length of the Americas from the latitude of Buenos Aires (Argentina) and Porto Alegre (southernmost Brasil) northward to southern Ontario (Canada). The bees' spatial prevalence, ubiquity and local abundance are not known, however, and so there is a lack of documented evidence for its importance for pollination of cultivated squashes and pumpkins. A continental (or hemispheric) survey for this system can be organised, if enough colleagues can be co-opted to dedicate three to eight early mornings of focused effort, plus a some modest time for initial local reconnaissance and later data entry.

In this first trial year, beginning January 2004, a handful of cooperators across North America have participated (see map), including one colleague in Mexico, with another pending. A listserv has been set up to permit collaborators to discuss, evaluate, and agree upon all of the details, protocols, and analyses of the survey. The listserv has subsequently been used to submit and redistribute data, as well as credit and partition additional tasks for those willing and able to take leadership for various components. (e.g. analysis, writing). More recently, tentative agreements to participate, have come from bee biologists in Argentina, Brasil, and perhaps Colombia and Panama. More of the map describing the distribution of squash and squash bees in the neotropics needs to be filled in, especially in Central and northern South America.

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The latter hosts an estimated 1 million *Peponapis* bees, and the grower currently spends \$25,000 annually to rent honey bees for what is probably superfluous pollination service. The oldest sites have had continuous squash production for >½ century; one has records dating to 1871.

#### IV. Analysis:

*Please also discuss any linkages with other Elements of the IPI, namely Assessment, Capacity Building, and Mainstreaming.*

The survey has just begun, thus the results cannot yet be reported, nor analysed. But the survey is also valuable for the information that can be shared on its sampling design and methodology.

In terms of data collected, sampling design has been guided by the following practical considerations, and overall principles of organization:

1) Interpretability is key. There are good published data for pollination requirements and pollination efficiency of *Peponapis* and *Apis*. Building on that, we want to establish the continental importance of *Peponapis* as a pollinator of domestic Cucurbita. For that we use data or estimates for bee abundance, visitation intensity, and the “scale” of the pollination task, and some estimate for the fruiting consequences of their pollination service. Strict uniformity and consistency is needed across all sites, to facilitate analysis and easy comparison. This benefits both the regional analyses and overall comparisons. The goal is maximum data return for modest effort. In this first trial year, we have comparable samples at sites ranging in size from a dozen plants to 80 ha. Once on site, collaborators found that the census takes about 10 minutes. All census data currently resides on a simple Excel spreadsheet from which site data can be compiled and analysed.

2) Time and labor allocation is minimized. Collaborators have time and travel burdens during the field season, and those in big cities could have long drives to squash or pumpkin patches. Each site needs to be visited at least once to gather bee, bloom and plant data. A pre-season visit may be needed to see the site and learn of cultural practices and their history from the grower. In the coming months, we will develop some fruit set/pollination measures to relate floral visitation intensity by *Peponapis* to satisfaction of pollination needs. This might be performed for just one site per locality, where summer squashes are grown (e.g. zucchini), as these are most amenable to estimating pollination response. Most localities are being represented by 2-4 squash/pumpkin/gourd patches, most with at least 30-40 plants. The data collected and its explanatory details is to be found on the two accompanying spreadsheets (seePepoBee.xls, and PepoBeeExcelnotes.doc).

It was initially thought that the coordinator would assume the responsibility for data analysis and manuscript writing for the entire survey. However, in listing the potential participants, it became evident that the task can be partly dispersed geographically, both to decentralize analysis and writing and better spread credit and effort around. Guidance in encouraging decentralized leadership in this regard will be welcome.

Groups of nearby collaborators can coordinate the research and writing of a manuscript for their “region”. The region should be big enough to encompass at least 3-4 widely separated localities, to allow for some regional generalization. “Regions” might be circumscribed as “eastern U.S.”, “western U.S.”, “Brasil” or “Mexico”, for example, with the lead author writing the manuscript.

Because collaborators will be using identical protocols, they can cite each other’s regional manuscripts for comparisons outside of our own region, but tailor each manuscript to regional results and circumstances. The coordinator will then take the lead in writing the manuscript encompassing all regions, citing each of the regional studies. Contributing co-authors are welcome.

Currently the survey is unfunded. For most North American participants, the cost of contributing to the survey can be absorbed in extant budgets. For participants in Central and South America, the coordinator hopes to find funding to provide modest but valuable means of compensation.

Of the twelve principles of the Ecosystem Approach, this case study probably most closely relates to Principle 5: "Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach". By documenting the contribution of unmanaged native bees to crop production, the case study should be able to provide convincing evidence that essential ecosystem services are provided by conserving ecosystem structures and functions. It probably is not clear yet exactly what structures and functions are essential to promote squash bees in squash cropping systems, but the survey's results will ultimately have comparative information between a wide range of farming systems.

The survey also respects Principle 2:"Management should be decentralized to the lowest appropriate level". Indeed, as the Parties to the Convention on Biological Diversity note, "the closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge". The sampling design invites interested parties to undertake a survey exercise on the local level, to own and be responsible for that information and add to its value by sharing across localities with other collaborators.

The survey seeks to identify, and quantify, the pollination services provided by wild unmanaged bees in squash agroecosystems in North, and possibly, Central and South America. The beneficiaries of the survey will be farmers, land managers, and consumers in this region. The actual means of adaptively managing wild pollinators is not the subject of the survey, but would be a logical follow-up study. The scale of the work is based on local surveys, compiled together to permit comparisons across increasingly larger regions.

## **V. Conclusions.**

Conclusions are premature at this time...