Why are bees ecologically important?

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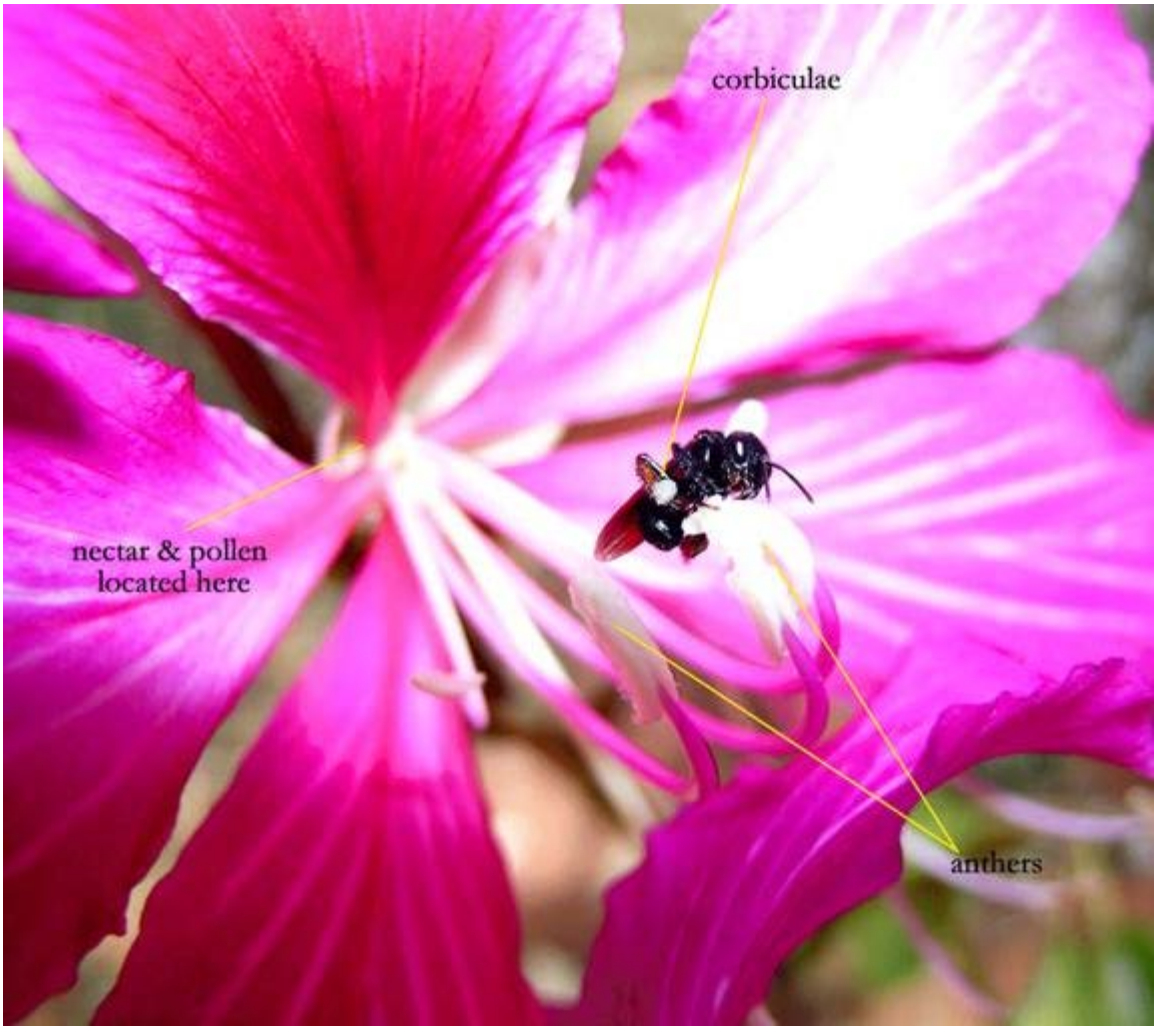

Figure 1. *Trigona spinipes* forager collecting pollen

I. Principles introduced in this exercise

- **A. Pollination: the flowers & the bees**
- **B. Importance of native pollinators**
- **C. Human agriculture and pollination**
- **D. Bees & plant biodiversity**

II. Introduction

Pollen is produced by a flower's *anthers*, which are at the outer end of the *stamen*, the flower's male sexual organ. A flower's female sexual organ is the *pistil*, which has an outer sticky end called the *stigma* (see Fig. 1). When pollen is transferred from the anther of a flower on one plant, to the stigma on a flower of another, it is called *sexual reproduction*. Sexual reproduction is advantageous in a constantly changing environment (which most environments are) because it produces genetically varied offspring (the offspring receive genes from both the male and female). Since the ultimate goal of any organism is to pass on the most genes (or copies of itself), producing diverse offspring will allow those that come out better suited to their environment to survive and reproduce more than those that are not as well adapted to their environment. Although some flowers self-pollinate (the pollen is automatically deposited onto the stigma), most flowering plants require a

pollinator to transfer pollen from the anther of one plant to the stigma of another.

Pollination can be accomplished by many animals such as birds, insects, and bats; some species of plants even rely on wind. Bees are one of the most well known and important types of pollinator, both in agriculture and natural ecosystems. Pollination by bees occurs when a foraging bee brushes against the anthers causing pollen to stick to her body. When the bee touches the stigma while searching for nectar at the center of the flower, some pollen grains are left on its sticky surface. Bees also use pollen as a food source; it is collected from the anthers into an area on their legs called the *corbiculae*, which contain specialized hairs that hold the pollen in place (see Fig. 1).

The flowers of different plant species often require different behavior by collecting bees. Since plants can't get up and walk around to reproduce sexually, many flowers are *mellitophilous*; they have coevolved with their pollinating bee species and as a result have specially designed stigmas and pistils that when foraged by a familiar bee, are more likely to result in pollination. This has resulted in *specialist* bees, which may forage exclusively on a single type of flower. Despite this phenomenon, many bees (such as honeybees) are *generalists*; they have broad food preferences and therefore forage from many different kinds of flowers. This phenomenon has been exploited in agriculture, as farmers have imported the European honeybee (*Apis mellifera*), which was domesticated for its honey production, to pollinate many different crops. However, honeybees are not efficient pollinators of all crops and wild plants because, as discussed above, they are generalists and are not always a not always a good fit for all flower shapes and sizes.

The flowers of most crops are often visited by an assemblage of insects, many native to a particular region. The importance of these native pollinators in the reproduction of flowering plants (including those used in agriculture) is just beginning to be understood. Unfortunately, there has been a major decline in native pollinators due in part to habitat loss and alteration, introduced species, and pesticide use. Habitat loss due to intensive agriculture, deforestation, and urban development reduces available food resources and nest sites for native bee species. Declines in wild bees due to competition for food resources from managed honeybees and displacement of native plants by introduced plant species have been shown to have severe effects on overall pollination. The use of pesticides to control agricultural pests does not discriminate between pest and pollinator, and is thus also a likely contributor to the dwindling populations of native pollinators.

Figure 2. Most of these fruits are bee-pollinated, but one is not. Can you guess which one? *Answer: Bananas are not pollinated by bees.*

As a result of this decline in native pollinators and the spread of disease among domesticated honeybees (likely a direct result of intense monoculture), there is a current pollination crisis, both in agriculture and nature. Each year, bee pollination is vital to millions of U.S. agricultural crops. Bees are responsible for pollinating 15 to 30% of all the food that U.S. consumers eat, and the economic benefit of pollination services has been estimated to be as high as $117 billion a year.

It is clear that the conservation of bees and other pollinators is an urgent issue. Our activities are destroying the diversity of all wildlife, and having an affect on our own food supply. Clearly a balance between the biodiversity of natural environments and a system of sustainable agriculture is needed. Farmers are beginning to turn to native pollinators as a viable option for crop production however, little is known about the majority of native bees. We must learn more about the ecology of these species and classify the many unknown pollinating species in order to assess the role of bees and other insects in pollination and put them to use in sustainable agricultural systems.

III. Discussion questions & activities

A. Can you identify foods that you eat that are bee pollinated?

Some foods that are pollinated by bees: apple, apricot, avocado, blackberry, blueberry, cranberry, gooseberry, raspberry, strawberry, cherry, grapefruit, lemon, mandarin, nectarine, tangelo, tangerine, kiwi, mango, passion fruit, peach, pear, persimmon, plum, prune, almond, cashew, chestnut, coconut, macadamia, soybeans, sunflower, asparagus, broccoli,

brussel sprouts, carrots, cauliflower, celery, Chinese cabbage, collard, cucumber, dill, eggplant, garlic, kale, kohlrabi, leek, lima beans, mustard, onion, parsley, pepper, pumpkin, radish, rutabaga, squash, turnip, beans, cantaloupe, cucumbers, pumpkin, squash, watermelon, eggplant, peppers, alfalfa, buckwheat, clover.

B. Come up with a menu of what your family eats for dinner during a typical week. Write it up on the board, divided into categories (fruits, vegetables, dairy, meats, grains, etc.). Then subtract all of the foods that are bee pollinated. Remember, many cattle are fed on crops such as alfalfa and clover! Pollination can therefore affect things such as the supply of meat and milk. After you have subtracted out all the bee-pollinated foods, try to come up with a new menu. What would you eat in a world with no bees? Try http://www.epicurious.com to find some recipes without bee pollinated foods.

IV. Selected References

Aluri RJS, Reddi CS (1994) Pollination ecology and mating system of the weedy mint *Leonotis nepetaefolia* R.Br. in India. Proceedings of the Indian National Science Academy Part B Biological Sciences 60:255-267

Amano K (2001) Applied researches into the utlilization of stingless honeybees as pollinators of crops in Japan. In: Quezada-Euán JJ, May-Itzá MCW, Moo-Valle MCH, Medina JCC (eds) II Seminario Mexicano sobre Abejas sin Aguijon. Departamento de Apicultura, Facultad de Medicina Veterinaria y Zootecnia, and Universidad Autonoma de Yucatan, Mérida, Yucatán, México, pp 132-133

Biesmeijer JC, Born M, Lukacs S, Sommeijer MJ (1999) The response of the stingless bee *Melipona beecheii* to experimental pollen stress, worker loss and different levels of information input. Journal of Apicultural Research 38:33-41

Crane, E (1990) Bees and beekeeping: science, practice, and world resources. New York, Cornell University Press.

Eltz T, Brühl CA, van der Kaars S, Chey VK, Linsenmair KE (2001) Pollen foraging and resource partitioning of stingless bees in relation to flowering dynamics in a Southeast Asian tropical rainforest. Insectes Sociaux 48:273-279

Heard TA (1994) Behaviour and pollinator efficiency of stingless bees and honey bees on macadamia flowers. Journal of Apicultural Research 33:191-198

Heard TA, Hendrikz JK (1993) Factors influencing flight activity of colonies of the stingless bee *Trigona carbonaria* (Hymenoptera: Apidae). Australian Journal of Zoology 41:343-353

Kakutani T, Inoue T, Tezuka T, Maeta Y (1993) Pollination of strawberry by the stingless bee, Trigona minangkabau, and the honey bee, Apis mellifera: An experimental study of fertilization efficiency. Researches on Population Ecology Kyoto 35:95-111

Kato M (1996) Plant-pollinator interactions in the understory of a lowland mixed dipterocarp forest in Sarawak. American Journal of Botany 83:732-743

Kearns CA, Inouye DW (1997) Pollinators, flowering plants, and conservation biology. Bioscience 24:198-199

Kevan PG (1975) Pollination and environmental conservation. Environmental Conservation 2:293-298

Kevan PG (1991) Pollination: keystone process in sustainable global productivity. Acta Horticulturae 288:103-110

Kevan, PG, Imperatriz-Fonseca,VL (2002) Pollinating bees: the conservation link between agriculture and nature. Proceedings of the workshop on the conservation and sustainable use of pollinators in agriculture, with emphasis on bees, São Paulo, Brazil, Ministry of Environment, Bárbara bela, Editora Gráfica, 313.

Ramalho M (1990) Foraging by stingless bees of the genus, Scaptotrigona (Apidae, Meliponinae). Journal of Apicultural Research 29:61-67

Ramalho M, Giannini C, Malagodi-Braga KS, Imperatriz-Fonseca VL (1994) Pollen harvest by stingless bee foragers (Hymenoptera, Apidae, Meliponinae). Grana 33:239-244

Sazima I, Sazima M (1989) Carpenter bees and stingless honeybees (Hymenoptera, Apoidea): Visiting, interactions and consequences for the pollination of the passionflower (Passifloraceae). Revista Brasileira de Entomologia 33:109-118

Slaa EJ, Sanchez LA, Sandi M, Salazar W (2000) A scientific note on the use of stingless bees for commercial pollination in enclosures. Apidologie 31:141-142

Wilms W, Wiechers B (1997) Floral resource partitioning between native *Melipona* bees and the introduced Africanized honey bee in the Brazilian Atlantic rain forest. Apidologie 28:339-355