Pollen Quality Versus Quantity

Subjects: Agriculture, Dairy & Animal Science

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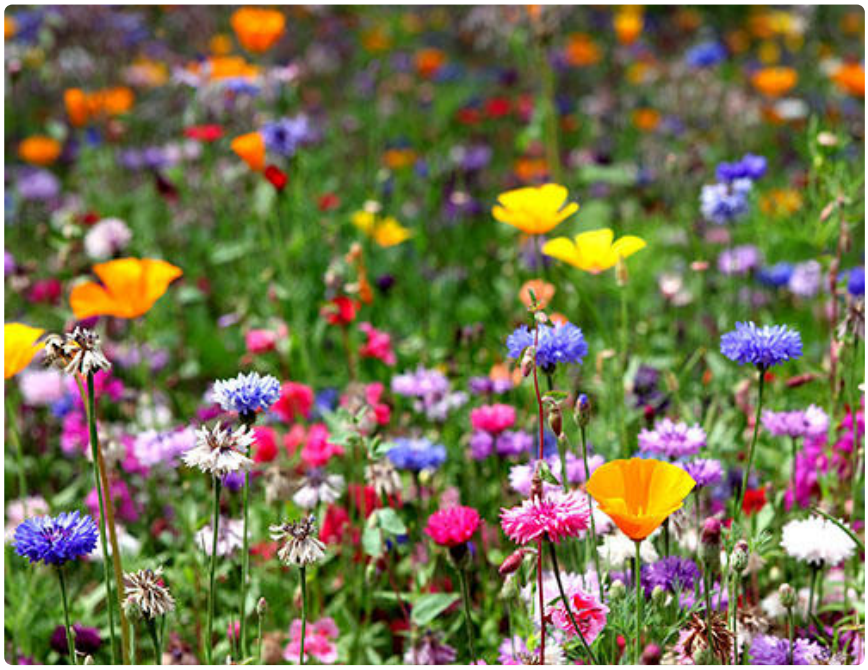
Do bees really benefit from the conservation attempts made by us? A study performed recently showed that wild bees do not use plant species sown in wildflower seed mixtures as pollen sources, and it concluded that plant species currently promoted by agri-environmental schemes are not optimal for bees. I have taken a closer look at the factors that determined whether pollen was healthy food for the wild bee larvae or not and the results have led me to propose that a major shift in the perspective of what we considered as bee-friendly plants was definitely warranted.

bees wild bee osmia pollen nutrition conservation bee food quality quantity development ecological stoichiometry stoichiometry bee-friendly plants

1. What Are Bee-Friendly Plants?



Children, compared to adults, need more nutritious food for growth and development. A diet of cookies and chocolates would never do for a growing kid. Similarly, feeding bee larvae with nutritionally unbalanced diet would cause them to be underdeveloped and most often result in their death. Nectar is sugar rich and provides adult bees the energy required to perform their daily tasks and they can help themselves to a buffet of nectar and pollen

served by the trees, shrubs and other flowering plants; however, pollen collected by the mother bee is the main source of food for the bee larvae.

For a baby bee to grow into a healthy adult, high-quality food, rich in non-sugar compounds, is essential. Bee-friendly plants grown for bee conservation purposes are chosen based on the quantity of food they produce and on the flower visitation rates by adult insects foraging for energy. Thus, due attention is not paid on their nutritional value for the young bees. Providing them pollen from such plants is like feeding them junk food. This is counterproductive to the actions undertaken to improve the nutritional base of wild bees.

2. How to Revive the Bee Population?

As a novel approach for addressing the issue of wild bee decline, I have developed effective strategies for bee conservation by considering the nutritional requirements of the larvae. By growing plants that supply the right food, we could ensure a revival in the bee population. As a start, plants that provide nutritionally balanced larval diet for a particular bee species (*Osmia bicornis*) were identified. This knowledge could be applied in the cultivation of bee-friendly plants as well as planting flower strips and hedgerows to act as pollen harvesting grounds for the bees.

Biological stoichiometry determines the proportions of various atoms that make up living organisms and their food sources and is used as an ideal framework for studying how food nutritional quality influences organisms and shapes their environmental interactions .

3. Quality of Pollen and Bee Larval Growth: Unraveling the Connection Using Biological Stoichiometry

Every compound is made up of atoms in specific proportions; stoichiometry is the proportion of the atoms present in a compound. **Organic compounds that act as substrates in the process of body-building in the bee larva can be converted into one another but one atom cannot be transformed into another. It is immutable.** Sugar is made up of only three elements: carbon, hydrogen and oxygen. Pollen, however, is made of various organic substances, including sugars, fats, proteins, amino acids and vitamins, which are built from elements such as carbon, hydrogen, oxygen, nitrogen, phosphorus, sodium, potassium, zinc and approximately twenty others. Atoms of all these elements are incorporated into the bodies of growing bee larvae. Therefore, the proportion of atoms that build the bee's body may be understood as bee nutritional demand and the proportion of atoms that build the bee's food may be understood as nutritional supply.

Based on this, the demand may be compared with the supply, thus raising the question: "Do all plants produce pollen that is rich in the necessary nutrients?" Apparently, they do not and that is the crux of the issue.

A difference can exist between the composition of atoms required for growth by the larvae and that of the pollen of plants in an area where bees visit. This is termed a stoichiometric mismatch [1]. The greater the stoichiometric mismatch between the proportions of atoms building the adult body of an organism and its larval food is, the stronger is the limiting effect posed on larval growth and development, resulting in an underdeveloped adult or death before maturation.

4. Bee Friendliness of Plants Related to Quality of Pollen

In this study, the atomic structure of the body of a wild bee was compared with the chemical composition of various pollen species. It turned out that the wild bee is particularly in need of nine atoms: phosphorous, sodium, manganese, magnesium, potassium, iron, calcium, zinc and copper.

What does this mean? Let's imagine there's Plant A and Plant B. Pollen A is rich in phosphorous, but lacking in sodium. The converse is true for Pollen B. Collecting pollen from only one plant would negatively affect the larva's growth and development; however, combining pollen from both plants would give it a balanced meal. So, **we should stop thinking about "bee-friendliness" of plants in terms of how much of nectar and pollen they produce but rather in terms of how high is the quality of the pollen they offer.**

5. Quality vs. Quantity

Monoculture may hamper the bees' development. For instance, pollen produced by sunflower and lavender contains very little phosphorus, an element crucial for synthesizing proteins in cells, which aids in the growth of the entire organism. Bees forced to live solely off these pollens would develop more slowly, into smaller adults and die more frequently. Examples of other plants producing low quality pollen are thistles, knapweed, dandelion, rapeseed and maize. So, specific plants with pollen rich in nutrition can be grown near monoculture plantations so that they can benefit the bees. For this, we need to know which plants produce pollen nutritionally balanced for wild bees. Do we have such a knowledge? Surprisingly… NO!

Therefore, based on the experimental and literature data, I estimated for the first time the supply of nutrients in pollen produced by 62 plant species within the context of nutritional demand of wild bee.

Of the 62 pollen taxa scrutinized, I found 30 to be highly limiting for the wild bee's growth. Furthermore, I have indicated 14 native, alien and cultivated plants that can promote the nutritional balance of bee larval

diet (e.g. some clover species, broad bean, St John's wort, blackberry, walnut and common camelia). The complete list is presented in supplementary materials published along with the study [3].

The information in the above mentioned study [3] is only a drop in the ocean compared to the amount of data that is needed. A better understanding of the nutritional ecology of wild bees is crucial for the effectiveness of conservation efforts. More specific data are required in conservation strategies for wild bees, such as: (1) the nutritional requirements of larvae of various wild bees to understand bee nutritional demands and (2) the nutritional composition of pollen produced by different plants to understand the nutritional supply available in the environment. Understanding the relationship between (1) and (2) will allow us to develop effective management strategies for maintaining populations of wild bees.

6. Conservation Implications

Proper management of bee habitats does not currently exist because the nutritional ecology of wild bees is not understood and actions undertaken to improve their nutritional base are not effective as discussed above.

Conservation strategies, such as planting flower strips and hedgerows and producing seed mixes, should include key host plants that offer pollen rich in nutrients that are essential for bee larval development. In future, building a knowledge base of nutrition in pollen from different plants and that of nutritional demands of other species of bees would help in the conservation of the bee population.

MENU BEE

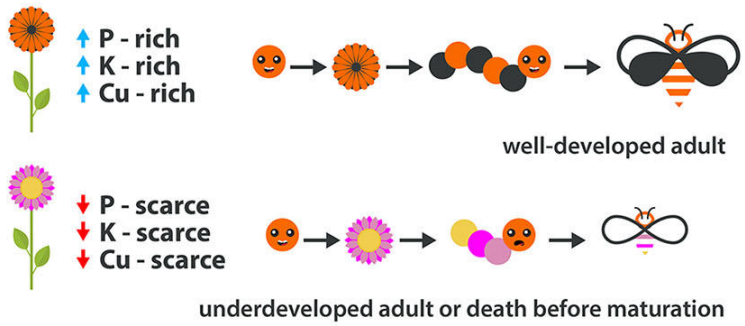
considering larval nutritional needs
in plant mixes for bees

LARVAL NEEDS FOR BODY-BUILDING MATTER

The growth and development is subject to the law of conservation of mass. Thus, organisms build their bodies by relying on thousands of chemical reactions, all of which must be chemically balanced. Therefore, insufficient concentrations of certain atoms in food prevent the production of tissues and physiologically important molecules that are constructed from this food either by the consumer itself or by its microbiota.

DEMAND VS. SUPPLY

The larva will be able to develop into healthy, fit and fertile adult only if it assimilates body-building atoms in right proportion. To allow for this, the larval diet must be stoichiometrically balanced, i.e. it must provide different atoms in right proportion. Only key plant species provide nutritionally balanced pollen:



GOOD QUALITY POLLEN

Trifolium repens, Vicia faba, Hypericum perforatum, Rubus ulmifolius, Camellia japonica, Sinapis arvensis, Juglans nigra

POOR QUALITY POLLEN

Lavandula, Brassica napus, Helianthus annuus, Zea mays, Trifolium balansae, Papaver rhoeas, Taraxacum vulgare

Access to key plant species that allow nutritionally balanced larval diets may be essential for bee development, whether food is gathered intentionally or randomly. Such plant species – and not only those rich in nectar and pollen – should be promoted in wild bee conservation efforts, including planting flower strips and hedgerows. Bee-friendly plants should not be defined and planted solely based on the quantities of food they produce and on the visitation rates of adult insects foraging for energy.

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