Pollen as Bee Medicine: Is Prevention Better than Cure?

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Context

When faced with an infection, endogenous defences in insects require a certain amount of energy. To reduce these costs, organisms can modify their behaviour by ingesting specific exogenous resources. This modification of behaviour to treat themselves is known as "self-medication". In the context of parasitic stress, a medicinal effect can occur either by benefiting the host (i.e., tolerance effect) or by harming the parasite (i.e., resistance effect). In the present study, we focused on the medicinal effects of different pollen regimes on bumblebees parasitized by a gut trypanosomatid *Crithidia sp.*, with a preventive effect (i.e., a prophylactic effect) and a curative effect (i.e., a therapeutic effect) **(Figure 1)**. We also examined spontaneous pollen intake when given a choice of foods to assess the ability of parasitized bumblebees to exploit medicinal pollen (self-medication experiment).

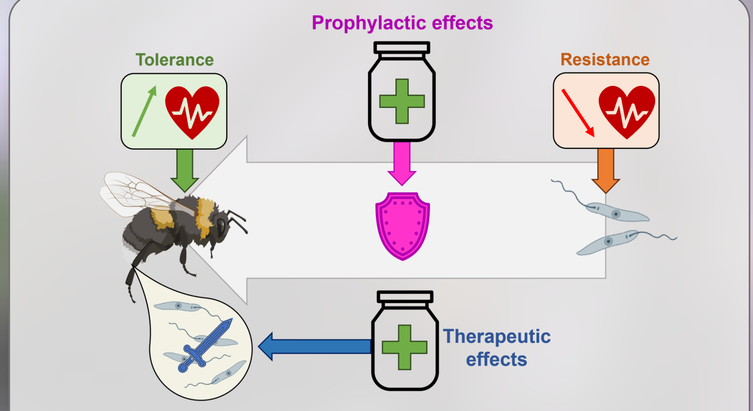

Figure 1: Medicinal effects include therapeutic effects, prophylactic effects, tolerance effects and resistance effects.

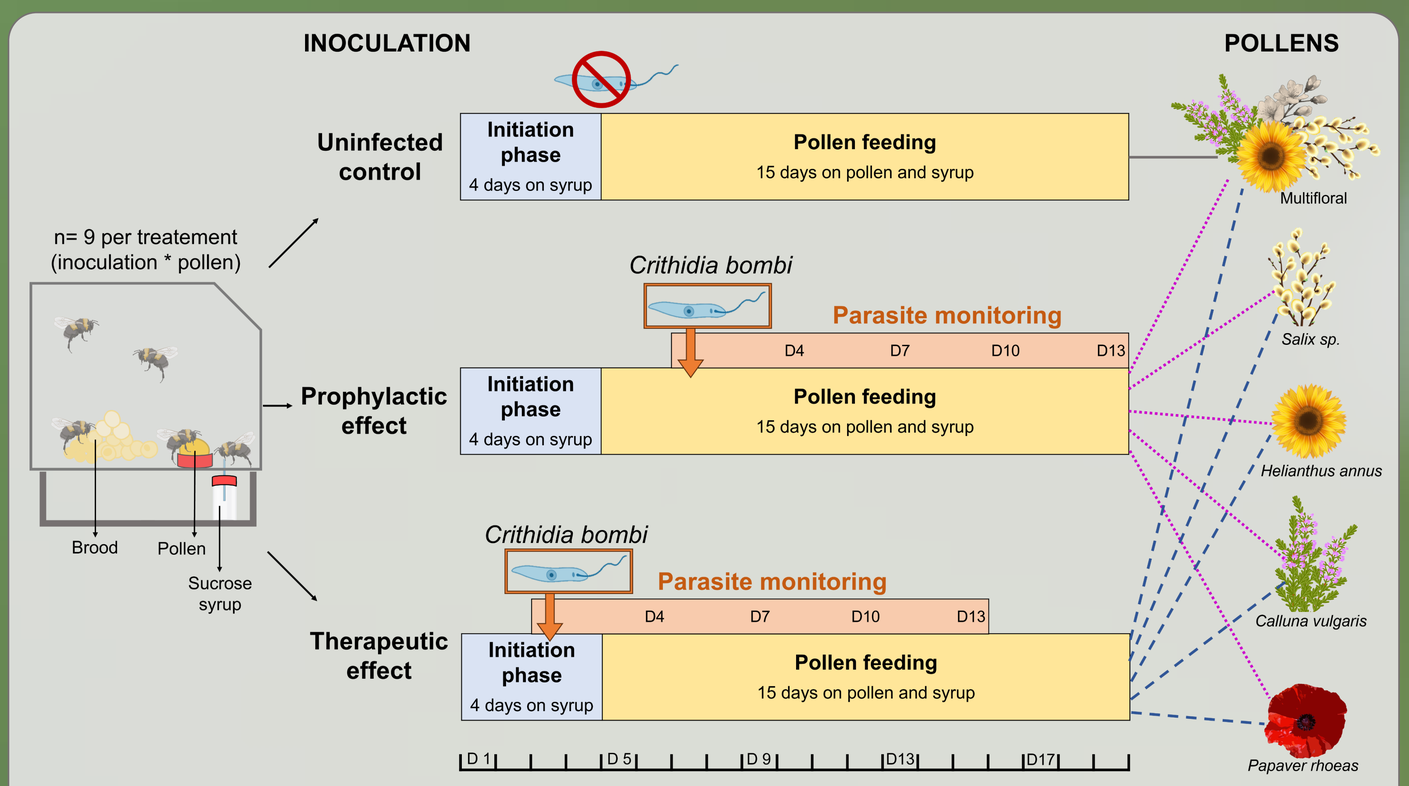

Figure 2: Experimental design used for testing prophylactic and therapeutic effects of five different pollen diets, including parasite inoculation and monitoring.

Materials and methods

The medicinal effects of pollen were studied using *B. terrestris* microcolonies, according to design, inoculation and monitoring displayed in **Figure 2.** The host tolerance effect is measured by the health of the microcolony (i.e., brood mass)**.** The parasite load is measured to assess the host resistance effect **(Figure 3)**. Once the medicinal pollen had been detected, we established a two-choice test to assess the ability of bumblebees to self-medicate **(Figure 4).**

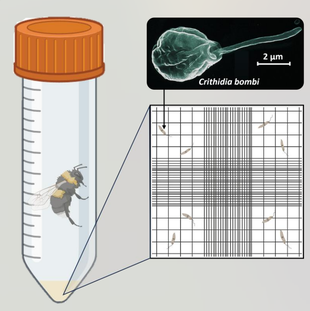

Figure 3: Parasitic load measured in the faeces of workers.

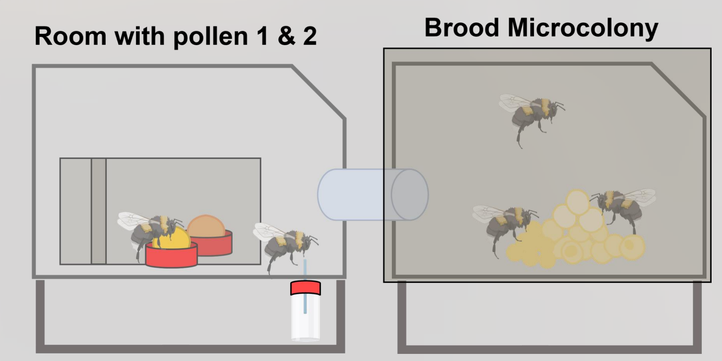

Figure 4: Experimental design used for testing self-medication.

Medicinal effects

Inoculation time had very little effect on host condition, with brood mass **(Figure 5)** tending to be higher for prophylactic treatments than therapeutic ones (significant for the multifloral diet). Possible hypotheses are:

- Pollen is used by the parasite, so less is available for the brood.
- Parasite reduces egg-laying efficiency
- Food deprivation makes the parasite more virulent

However, the diets (i.e., pollen) have effects on host tolerance in infected microcolonies **(Figure 5)**. Sunflower and heather pollen had noxious effects on host condition. These effects could be explained by the lower nutrient intake of these diets.

Parasite load was lower for heather and sunflower **(Figure 6)**, indicating a therapeutic resistance effect for these two diets and a prophylactic effect for sunflower. The next step is therefore to determine whether bumblebees display self-mediactive behaviours when offered one of these two diets.

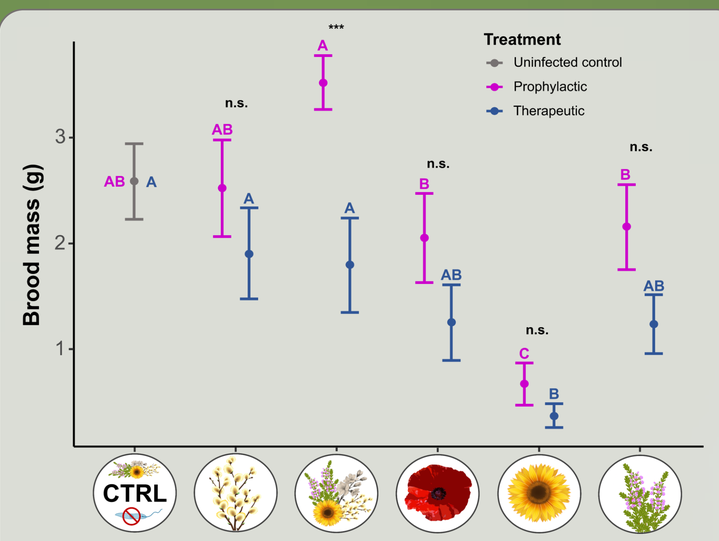

Figure 5: Brood mass after 19 days fed with different pollens and exposed to different treatments.

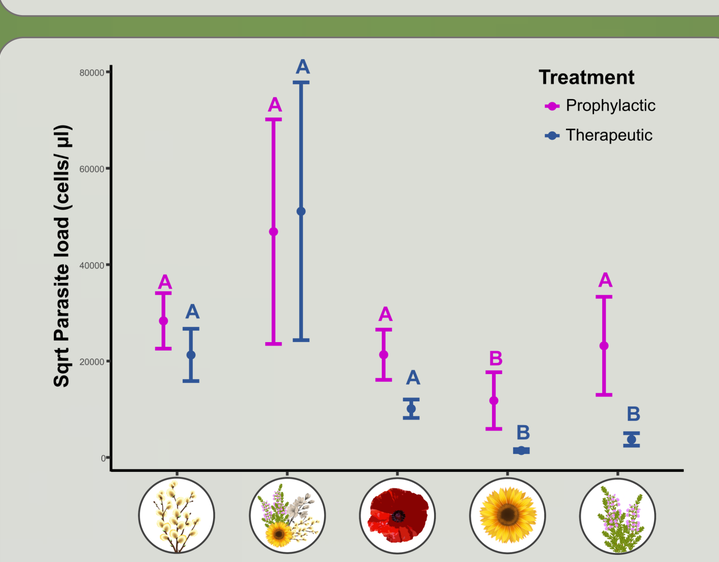

Figure 6: Parasite load 10 days after inoculation in the faeces of workers fed different pollen diets either prophylactically or therapeutically.

Self-medication

Criteria for self-medication

1. Compounds found in the environment
2. Compounds are not unknown
3. Ability to detect the compounds
4. More advantageous than own defences
5. Noxious in the absence of parasites
6. Advantageous in the presence of parasites

When bumblebees were offered a choice between a therapeutic and a control pollen, we found that infected bumblebees did not favour pollen with medicinal properties, nor they increased their overall pollen collection **(Figure 7).**

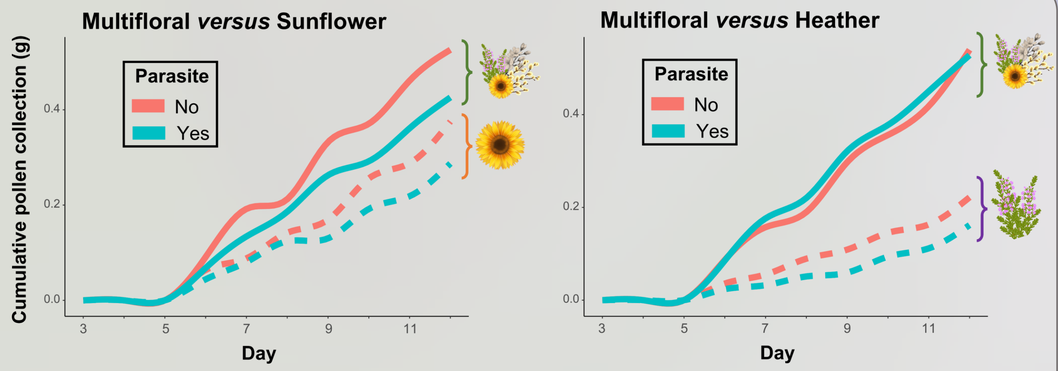

Figure 7: Cumulative pollen collection in healthy and infected workers offered a choice between two different pollen diets.

Limits and prospects

The heather and sunflower are not nutritious diets, which creates dietary stress. Furthermore, as the selected parasite is not very virulent, a nutritious diet is preferred to a medicinal diet. The fact that self-medication was not observed in our study does not mean that it does not occur in bumblebees. Further research with other more virulent parasites may be needed to assess the ability of bees to self-medicate.

***Nosema* sp.**

***Apicystis* sp.**

Reference:

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