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Propolis

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Propolis is the apicultural term for the plant resins that some ▶ honey bees collect and then deposit throughout the nest [11, 12]. Resin-handling bees within the nest mix varying amounts of ▶ beeswax with the resins during deposition. The primary chemical components of propolis are derived from the plant-produced resins, which contain chemically diverse lipid-soluble mixtures of volatile and nonvolatile terpenoid and/or phenolic compounds. Within the phenolic group of compounds, flavonoids are the most bioactive [4]. It is thought that bees do not consume propolis; they only manipulate it with their mandibles.

Various social species across the Hymenoptera (e.g., ants, ▶ stingless bees) collect and use resins for various purposes, including nest construction and as a defense against predators, microbes, and pathogens. Colonies of *Apis dorsata*, the ▶ giant honey bee, may use resin occasionally to strengthen the site of comb attachment on a branch. *A. florea*, a ▶ dwarf honey bee, places a ring of resin on the branches leading to a nest to prevent ants from invading the exposed nests. Interestingly, ▶ *Apis cerana* is reported to not collect resin [1]. The resins that stingless bees use in nest construction are referred to as geopropolis or cerumen. In these species, the full function of their use of resins is understudied, though it appears to have some role in chemical communication/recognition of conspecifics and defense against predatory ants [5, 6].

Subspecies of ▶ *A. mellifera* vary greatly in their tendency to collect propolis. Caucasian honey bees, *A. m. caucasica*, from the Caucasus area in Europe, are known for their tendency to collect great quantities of propolis. African honey bees, including Africanized bees found in tropical America, also collect great quantities of propolis. Some colonies, regardless of subspecies, also collect large quantities of propolis and may reduce a colony entrance so that only a few holes 1–1.5 cm in diameter remain for the bees to enter and exit.

A. mellifera colonies that nest in tree hollows line the interior walls and often the nest entrance with a layer of propolis 0.3–0.5 mm thick [8]. This propolis envelope surrounds the colony and likely serves many non-mutually exclusive purposes, including waterproofing and preventing fungal decay of the hive walls, reducing cracks and hive entrances, helping promote a stable temperature and humidity through condensation, entombing small vertebrates and hive beetles, and reducing hive microbial loads.

The benefits of propolis to bee health, determining the plant sources of propolis, and mining of new antimicrobial compounds from resins, are active and rich areas of current and future research

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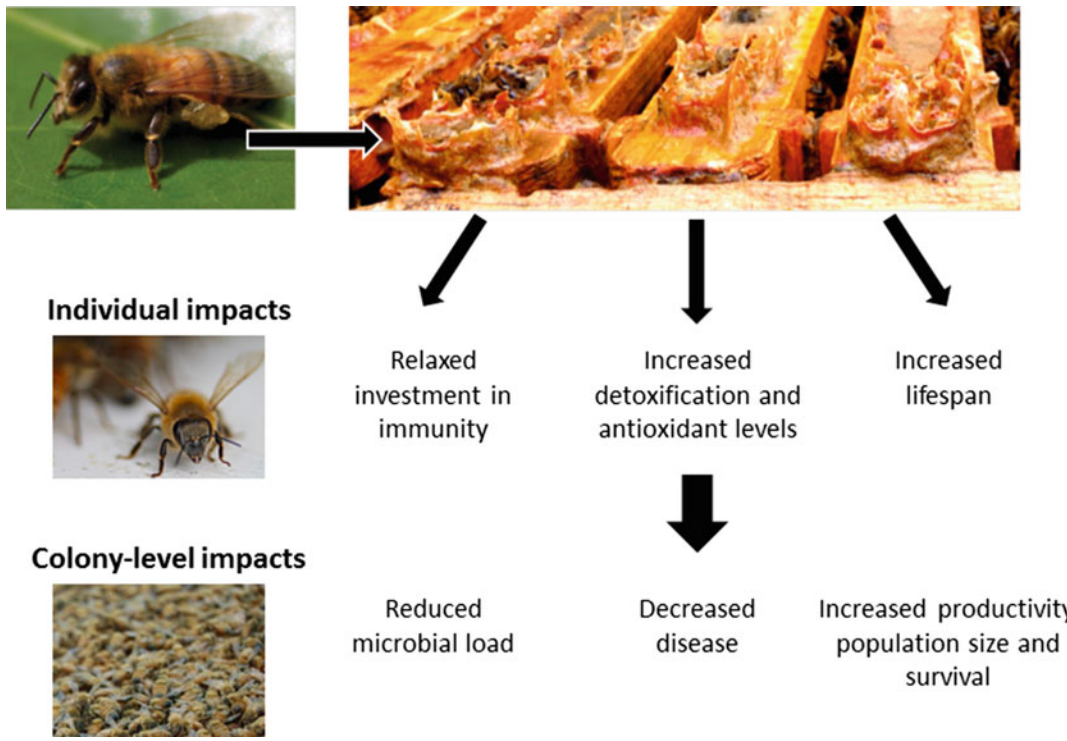
(Fig. 1). Beginning in 2009, research in the lab of M. Spivak at the University of Minnesota revealed the constitutive and therapeutic effects of the propolis envelope to the colony's "social immunity" [11, 12]. The propolis envelope alters the amount and/or community of microbes within the nest cavity, in turn reducing the need for the bees to activate their immune systems [2, 7]. A propolis envelope also reduced the colony signs of two diseases, chalkbrood (caused by the fungus *Ascosphaera apis*) and American foulbrood (caused by the bacterium *Paenibacillus larvae*), compared to colonies with no propolis envelope. After colonies were experimentally challenged with the chalkbrood-causing fungus, the number of resin foragers increased relative to the number of resin foragers before the challenge, suggesting that bees might be using resin as self (or social) medication. Other researchers have shown that this form of social medication may also occur due to parasitism by the mite *Varroa destructor* and/or be responsive to viral infection, which the mites vector (reviewed in [12]). Additionally, exposure to propolis may stimulate detoxification enzymes and immune function, though these two particular aspects need to be studied under more natural conditions (reviewed in [12]). Work on Africanized honey bees in Brazil have also indicated that bees bred for increased propolis production have increased lifespans and the high propolis colonies have increased honey yields as well (reviewed in [12]).

The plant sources of resins are being researched around the world, and the antimicrobial properties of resins from different plants are being quantified. For example, in northern temperate regions of North America and Europe, trees in the genus *Populus* (e.g., cottonwoods, aspens, balsam poplars), seem to be the preferred sources of resins to honey bee colonies. In Brazil, the identified botanical source of green resin is from *Bacharris dracunculifolia*, and of red propolis is from various species in Leguminosae and Clusiaceae (or Guttiferae).



Propolis, Fig. 1 Overview of the impacts of honey bee-harvested plant resins on individual and colony health. (Figure reproduced [3] with permission, photos by Michael Simone-Finstrom)

When bees deposit propolis in the cracks between stacked bee boxes and under the wooden frame rests of a hive, it makes management of the colony difficult. Thus, at least in the USA, there has been selection by beekeepers for more than a century against varieties and races of bee that collect large amounts of propolis. In contrast, in Brazil, there has been selection for increased propolis collection because propolis is a profitable hive product. Colonies of all subspecies of *A. mellifera* can be encouraged to build a propolis envelope by cutting and stapling commercial propolis traps to the inner walls of commercial bee boxes, which they will fill with resins. Beekeepers also can build bee boxes with the inside surfaces left unplaned and rough, so that the bees will coat the rough wood with a thin layer of propolis.

Propolis has been used in human medicine since antiquity [3, 10]. Beekeepers have harvested propolis from beehives to make medicinal tinctures, salves, ointments, chewing gum, and lozenges. There is ongoing medical research on the effect of propolis on human wounds and diseases (e.g., tumors, oral infections) [9, 10]. To harvest propolis, specially designed plastic propolis traps can be placed under the inner cover during the warm summer months. The traps have many thin (about 1.5 mm) slits that the bees fill with resin. After most of the slits are filled, the traps are placed in a freezer. When the propolis is frozen the plastic sheet can be placed inside a plastic bag, and then flexed. The propolis (sometimes) falls from the grid. This method produces clean propolis, free from any hive debris.

Cross-References

► Stingless Bees

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