Apimondia News

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# Bees for Chocolate: Potential Perspectives on Cocoa Pollination

*Cocoa production depends on insect pollination, particularly by flies. But could managed bees also provide valuable pollination services? A study conducted in Brazil has explored the potential of several stingless bee species for this purpose.*

By Matteo Giusti

Cocoa, as is well known, is one of the most important tropical crops because of its wide range of uses and its economic value. However, not everyone may know that cocoa production depends heavily on insect pollination. Due to self-incompatibility, *Theobroma cacao* requires cross-pollination.



Theobroma cacao *flowers (Photo by Vinayaraj - Wikipedia)*

Furthermore, its floral morphology and small flower size make it essential for pollination to be carried out by small insects capable of reaching the stigma. However, insects that are too small (less than 2 mm in size) may also be ineffective, as they may fail to come into contact with the male reproductive organs of the flower and therefore cannot transfer pollen efficiently.

Despite these considerations, relatively few studies have investigated cocoa pollinators and their activity. Moreover, the decline in pollinator abundance and activity in cocoa plantations is considered one of the main causes of reduced crop production.

A recent review, published in the Journal of Applied Entomology in 2025, reported that flies are the most important cocoa pollinators worldwide. In particular, flies belonging to the genus *Forcipomyia* were identified as key pollinators of cocoa flowers. However, other insects may also play an important role in cocoa pollination, including ants, aphids and bees, particularly some species of stingless bees.

In this regard, a study conducted in Brazil and published in Frontiers in Bee Science investigated the potential of small Amazonian stingless bees for targeted cocoa pollination. In fact, *Theobroma cacao* is native to the Amazon region, which is also home to 188 species of stingless bees (Meliponini). Based on existing scientific literature, the researchers selected 52 native species according to their morphological characteristics, which could make them particularly well suited to the structure of cocoa flowers.

Meliponini are generally considered opportunistic, generalist foragers, collecting nectar and pollen from a wide variety of flowering plants. Several small species have already been observed visiting cocoa flowers, including *Nannotrigona punctata*, *Nannotrigona sp.*, *Paratrigona subnuda*, *Plebeia flavocincta*, *Plebeia mosquito* and *Tetragonisca angustula*.

According to the study, when collecting pollen, stingless bee workers land on the ligule of a cocoa petal and insert their heads into the petal hood, where they extract pollen from the anthers through specific head movements. Furthermore, individual foragers

visit several flowers on the same cocoa tree and often move between different trees during a single foraging trip. This behaviour is particularly important because it can promote cross-pollination.



Theobroma cacao *fruits (Photo by Filipinayzd - Wikipedia)*

Another potential limitation to bee-mediated cocoa pollination is the low light intensity beneath the dense canopy of shade trees. This is especially relevant in small family-run farms, where cocoa is often cultivated in agroforestry systems.

Against this background, the study aimed to address five main questions:

1) How many stingless bee species can be considered potential cocoa pollinators, based on their natural geographical distribution and body size?

2) Which species are the most suitable candidates for managed cocoa pollination, considering their geographical distribution?

3) When are these species active during the day, and does their foraging activity overlap with the reproductive period of cocoa flowers and occur under suitable light conditions?

4) Do these bee species show a preference for a particular vegetation stratum?

5) Which species are cavity-nesting and therefore potentially more suitable for managed beekeeping using artificial hives?



Theobroma cacao *seeds. According to the literature at least 150 pollen grains are necessary to achieve top yields of between 50 and 60 seeds/pod (Photo by Filipinayzd - Wikipedia)*

The results revealed that several of these species have a relatively wide geographical distribution. In Brazil, 35 candidate species occur in Pará, the country's leading cocoa-producing state, while 10 are present in Bahia, the second-largest production area. Some species are also found across neighbouring countries, suggesting their potential application also beyond the Brazilian Amazon.

Regarding the bees' ability to forage under low-light conditions, considered a limitation for foraging activity, the study suggests that small stingless bees may be able to overcome this obstacle. Their activity levels appear to coincide with the reproductive cycle of cocoa flowers: bees are particularly active around midday, when cocoa stigmas reach their maximum receptivity and pollen is available for transfer. Moreover, the analysis of their food sources showed that understory plants account for approximately 33–73% of the vegetation visited by several species. This indicates that many of these bees are already adapted to foraging in shaded environments.

Also the nesting behaviour offers encouraging prospects for practical applications of stingless bees in managed pollination of cocoa. Of the 38 species for which nesting information was available, 21 build their nests in tree cavities, two nest underground and 15 use different types of nesting sites. And the species that naturally occupy tree cavities are particularly interesting because their colonies can potentially be transferred to artificial hives and managed near cocoa plantations.

In addition, several factors make stingless bees interesting organisms for complementing or even improving existing pollination services of cocoa. Unlike small flies, traditionally considered the main cocoa pollinators, stingless bees can travel considerably greater distances, potentially reaching almost one kilometre from their colonies. Stingless bees are also active throughout the year and have specialised structures for collecting and transporting pollen. Moreover their foraging activity

around midday further coincides with the period when cocoa flowers are most receptive to pollination.

However, the authors emphasise that their effectiveness as cocoa pollinators has not yet been demonstrated conclusively. Although some species have been observed visiting cocoa flowers, direct evidence that they successfully deposit pollen on the stigma remains limited.



Tetragonisca angustula *nest entrance. This species appears particularly promising for cocoa pollination (Photo by Sintropepe - Wikipedia)*

In addition, stingless bees may initially show little interest in cocoa flowers, particularly in modern cultivated varieties. One possible solution is targeted pollination, a technique in which colonies are exposed to the scent of the target crop

before being introduced into plantations. This process could encourage bees to recognise and preferentially visit cocoa flowers and specific studies have been already carried out on *Tetragonisca angustula*.

The researchers also stress the importance of preserving suitable habitats. Small stingless bees are particularly vulnerable to deforestation because their limited foraging ranges make them dependent on the availability of nearby food resources and nesting sites. Maintaining forest fragments, vegetation diversity and well-managed agroforestry systems will therefore be essential for supporting their populations.

Overall, the study identifies small Amazonian stingless bees as promising candidates for improving cocoa pollination. Among stingless bee species, *Tetragonisca angustula* appears particularly promising, given its role as a natural cocoa pollinator and its suitability for management in artificial hives.

Nevertheless, further research is needed to confirm their actual pollination efficiency, understand their foraging behaviour and investigate their ability to learn and respond to cocoa flower scents. If these challenges can be overcome, managed stingless bee colonies could become a valuable tool for increasing cocoa productivity while simultaneously supporting biodiversity and the sustainability of tropical farming systems.

**References**

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