

Attempting to understand the pollination secrets of the cacao tree

April 6 2022



Cacao tree with fruits and flowers. Credit: Justine Vansynghel / University of Wuerzburg

Cacao has long been a sought-after raw material for the world's food industry. At first glance, it therefore seems surprising that biology knows little about the pollination of the cacao tree—although it is precisely this process that is the basis for fruit set and ultimately for the yield.

At second glance, however, one quickly understands why the pollination of this tropical crop holds so many secrets: [cacao](#) flowers are very small and are usually found by the thousands on a tree. The insects that gather at the flowers are also tiny and very diverse in terms of species. All these factors make systematic observations difficult.

Study in the north and south of Peru

A new study now brings more clarity. It was conducted in Peru by an international research team at the Chair of Animal Ecology and Tropical Biology at Julius-Maximilians-Universität (JMU) Würzburg, Germany.

South America is the native region of the cacao tree, which occurs there in the undergrowth of tropical rainforests. In agriculture, too, the cacao tree is planted in the shade of larger trees, in so-called agroforestry systems. The researchers applied glue to cacao flowers in 20 such systems in northern and southern Peru to investigate which animals visit the flowers. They also analyzed the influence of the degree of shading and the distance to the nearest forest on visitor activity at the flowers.

The results have been published in the journal *Ecological Solutions and Evidence*. The first author is biologist Justine Vansynghel, who has been a doctoral student at JMU under Professor Ingolf Steffan-Dewenter

since 2018.

A wide variety of insects cavort on the blossoms

In the cacao agroforests in the dry north of Peru, aphids (38%), ants (13%) and thrips (10%), were the most frequent flower visitors. In the more humid south, on the other hand, thrips (65%), midges (14%) and parasitic wasps (10%) were the most common.

In the north, the researchers counted more insects on the cacao flowers the more shaded the plantations were. In the south, on the other hand, the insects preferred to stay in less shaded plantations, at least during the [rainy season](#) in which the study took place. The distance to the nearest forest did not play a role in the extent of flower visitation in either region.

Pollen transfer and fruit set remain poor

Justine Vansynghel's team also observed that only two percent of the pollinated cacao flowers set fruit. Transferring pollen by hand tripled fruit set to seven percent, which is still very poor.

The doctoral researcher can only speculate about the factors that limit fruit set. One reason could be that there are simply no efficient pollinators for cacao in Peru. This is suggested by the fact that only very few pollen grains were counted on most of the cacao flowers, an average of 30. Four times that amount would be needed for successful pollination, according to the literature. Another reason for low fruiting in cacao could be that the individual cacao plants are genetically incompatible with each other.

Many questions remain to be clarified

So there remain major gaps in our knowledge of the biology of the cacao tree. "Among other things, it would be important to identify the main pollinators," says Justine Vansynghel. Then it would also be possible to develop higher-yielding agroforestry systems and improved management strategies in the Peruvian native regions of the [cacao tree](#).

Why are cacao yields in Peru so much worse than in Africa or Asia? "In Indonesia, you can achieve a fruit set of around 50 percent with hand pollination. This is probably because the plantations there do not use the native South American cacao clones, but higher-yielding ones," explains the JMU researcher.

On the other hand, cacao plantations in Africa and Asia are threatened by so many diseases and pests that large monocultures can be eliminated at once. Another problem with the high-yielding, non-native clones is that they only produce good harvests for five to ten years. After that, old plantations are abandoned, and existing forest is cut back for new [plantations](#).

More information: Justine Vansynghel et al, Cacao flower visitation: Low pollen deposition, low fruit set and dominance of herbivores, *Ecological Solutions and Evidence* (2022). [DOI: 10.1002/2688-8319.12140](#)

Provided by Julius-Maximilians-Universität Würzburg

Citation: Attempting to understand the pollination secrets of the cacao tree (2022, April 6) retrieved 21 June 2024 from <https://phys.org/news/2022-04-pollination-secrets-cacao-tree.html>

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