

Figure 2. Soybean plants after an 18 day-exposure to caterpillars. Left: honeybees were flying past the leaves to the feeder. Right: no bees were flying inside the enclosure.

when caterpillars fed on fruit-bearing pepper plants. Here, although initially feeding on leaves, the beet armyworms soon moved into the maturing fruits (Figure 1C).

Our results indicate that visiting honeybees provide plants with a totally unexpected advantage: bees flying around plants inhibit the feeding intensity of herbivorous caterpillars, resulting in a clear reduction of leaf damage. Thus, honeybees not only transport pollen from flower to flower but in addition also reduce plant destruction by herbivores. A similar strategy has been described for extrafloral nectaries that attract ants [11]. We speculate that, apart from consumptive and nonconsumptive predator effects, pollinator–herbivore interactions may also be important factors to consider in attempting to understand community dynamics.

Supplemental Data

Supplemental data are available at [http://www.current-biology.com/supplemental/S0960-9822\(08\)01407-3](http://www.current-biology.com/supplemental/S0960-9822(08)01407-3)

Acknowledgments

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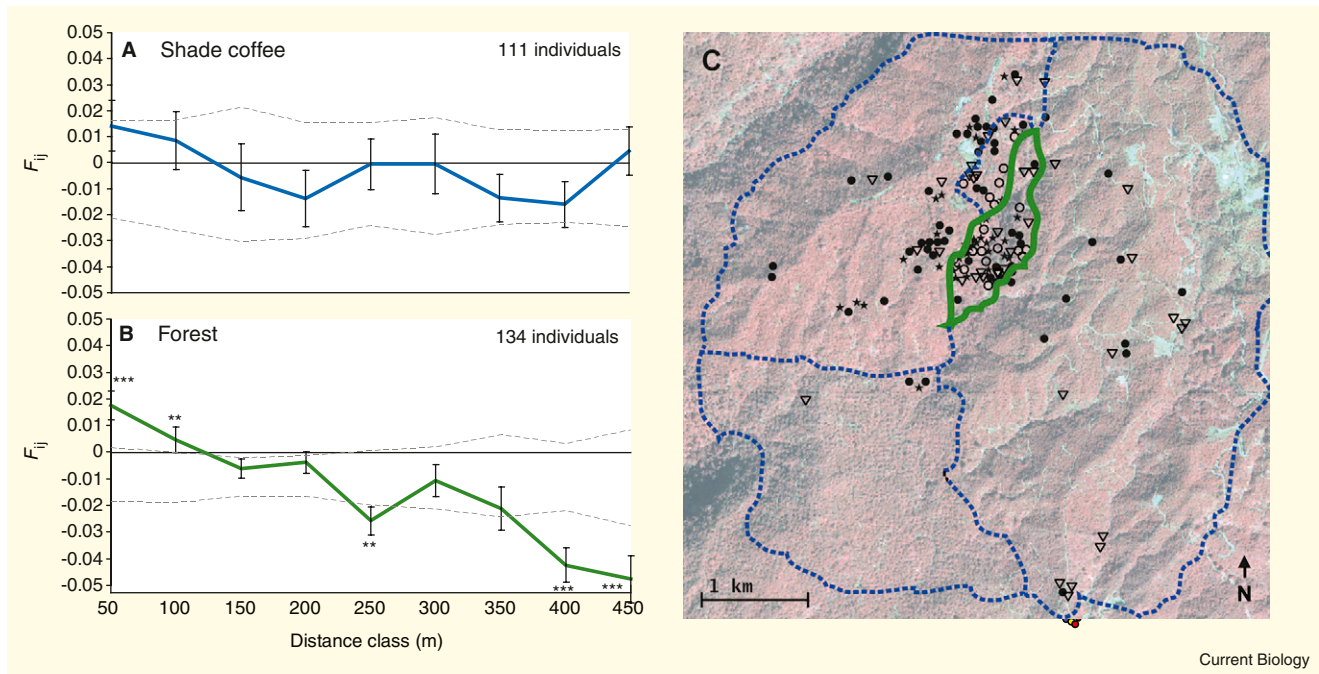
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Shade coffee farms promote genetic diversity of native trees

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Coffee is cultivated across 11 million hectares (ha) of land within the world's richest centers of terrestrial biodiversity [1]. In tropical America, coffee is traditionally grown under a diverse canopy of overstory shade trees, which enhances the quality of the coffee farm as a conservation matrix and supports a broad spectrum of pollinators that increase fruit set per bush [2–4]. Unlike sun coffee monocultures, shade coffee also sustains a diverse array of vertebrates, including bats and migratory birds, which provide farmers with many ecological services, such as insect predation [5], and may also conserve seed dispersal processes necessary for native tree re-establishment [6]. However, little is known about the capacity of shade coffee farms to maintain gene flow and genetic diversity of remnant tree populations across this common tropical landscape. In this study, we conducted genetic analyses that reveal recent colonization and extensive gene flow of a native tree species in shade coffee farms in Chiapas, Mexico. The high genetic diversity and overlapping deme structure of the colonizing trees also show that traditional coffee farms maintain genetic connectivity with adjacent habitats and can serve as foci of forest regeneration.

Previous genetic studies of forest regeneration in degraded tropical landscapes have focused on canopy trees and have found pronounced fine-scale spatial genetic structure within colonizing tree populations (e.g., [7,8]) as a result of limited seed dispersal from scattered maternal trees. Such population bottlenecks can lead to inbreeding depression and demographic declines for plants in fragmented landscapes. Alternatively, agricultural matrices that facilitate the movement of seed and pollen dispersers among habitats can increase the breeding size and genetic diversity of native plant populations.



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Figure 1. *M. affinis* kinship across multiple distance categories in shade coffee and forest habitats.

(A,B) Spatial autocorrelation diagrams showing kinship coefficient F_{ij} (solid lines) averaged across all pair-wise comparisons within distance categories. Dashed lines show 95% confidence limits (CL) around the null expectation of no genetic structure ($F_{ij} = 0.00$). Thus, values above the upper 95% CL represent significantly higher relatedness than expected at random, while values below the lower 95% CL represent significantly lower relatedness than expected for each distance class. (C) Mapped trees were assigned to four demes (filled stars, filled circles, open circles, open triangles) indicating extensive, overlapping seed dispersal. Solid green lines outline the forest fragment, and dashed blue lines outline the shade coffee farms. All analyses were based on 8 highly polymorphic, unlinked microsatellite loci.

We used genetic markers to analyze the dispersal history and spatial genetic structure of the understory tree *Miconia affinis* (Melastomataceae) within a network of coffee farms and forest fragments in Chiapas, Mexico. Though an integral part of tropical forests, relatively little is known about the population genetics of understory trees compared with canopy trees. Like many tropical understory trees, the seeds of the genus *Miconia* are dispersed by widespread large-bodied birds, such as the clay-colored thrush (*Turdus grayi*), as well as small-bodied scrub and forest specialists such as the chestnut-sided warbler (*Dendroica pensylvanica*) [9]; thus, its colonization patterns are likely representative of other understory vertebrate-dispersed trees. *M. affinis* is an obligate outcrosser and requires native bees (e.g., *Trigona* and *Scaptotrigona* spp.) for cross-fertilization through buzz-pollination, of which the ubiquitous Africanized honeybees are incapable. The survey area of 1,200 ha encompasses an uncut primary forest and three adjacent shade

coffee farms (Figure 1). The three farms were clear-cut and burned in the late 1930s and immediately replanted with coffee bushes and canopy tree species, including nitrogen-fixing legumes and many other fruit trees (means of 157.21 ha⁻¹ overstory trees, and 14.67 ha⁻¹ tree species). Since the creation of these coffee farms, farmers have allowed native understory trees, like *M. affinis*, to colonize the coffee plots because they help to reduce soil erosion.

Strong spatial genetic structure of *M. affinis* found in the forest plots (Sp statistic = 0.020) is similar to levels reported in species with extreme seed dispersal limitation [10]; in contrast, no spatial genetic structure was detected for any distance class within the coffee farms (Sp statistic = 0.006), revealing more extensive gene flow across the shade coffee matrix (Figure 1). Limited seed dispersal in the forest, relative to the coffee farm, may be due to the short foraging ranges of forest specialist birds. Using an individual-based clustering approach, *M. affinis* individuals in the landscape were assigned to four well-supported demes (96% posterior

probability), which were overlapping in space and not aggregated by habitat or age class, indicating that colonization into the farms was recent and from multiple source populations (Figure 1 and Table S1) [7]. Levels of *M. affinis* genetic diversity within the coffee farms did not differ from forest populations [7]. These results depart from previous agricultural colonization studies that report strong spatial genetic structure and reduced genetic diversity in the founding canopy tree populations, usually caused by the reproductive dominance of just a few maternal trees in the early colonizing stages [7].

By conserving resident bird populations, our results reveal that shade coffee farms support extensive dispersal processes crucial for the connectivity of remnant forest and agricultural habitats. The colonization pattern and high genetic diversity of *M. affinis* also points to the role of shade coffee farms as potential foci of native forest regeneration, as coffee farms typically fall out of production in less than a century. However, despite the clear ecological benefits of traditional shade coffee

farms, these farms are rapidly being converted to input-intensive monocultures [2,3]. Thus, it is imperative to highlight the ecological function of shade coffee farms, not only in providing refuge for native fauna, but also in preserving habitat connectivity and gene-flow processes essential for reforestation by native tree species.

Supplemental Data

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Intact navigation skills after bilateral loss of striate cortex

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A patient with bilateral damage to primary visual (striated) cortex has provided the opportunity to assess just what visual capacities are possible in the absence of geniculostriate pathways. Patient TN suffered two strokes in succession, lesioning each visual cortex in turn and causing clinical blindness over his whole visual field. Functional and anatomical brain imaging assessments showed that TN completely lacks any functional visual cortex. We report here that, among other retained abilities, he can successfully navigate down the extent of a long corridor in which various barriers were placed. A video recording shows him skillfully avoiding and turning around the blockages. This demonstrates that extra-striate pathways in humans can sustain sophisticated visuo-spatial skills in the absence of perceptual awareness, akin to what has been previously reported in monkeys. It remains to be determined which of the several extra-

striate pathways account for TN's intact navigation skills.

We investigated the residual vision for locomotion in TN, an unusual subject as the only available case in the literature with selective bilateral occipital damage (but see also [1] for a report on intact fear conditioning in a similar patient). TN suffered the first stroke that damaged his occipital cortex unilaterally, and some 36 days later a second stroke occurred that damaged the occipital cortex of the other hemisphere (Figure 1A). He was initially studied by Pegna *et al.* [2] while in hospital in Geneva after his second stroke. These first observations on TN showed affective blindsight in response to facial expressions, as indicated by condition-specific amygdala activation for emotional expressions of fear, anger and joy compared to neutral. We studied TN behaviorally, electroencephalographically and with brain imaging techniques, including diffusion tensor imaging (DTI), in Tilburg and Maastricht.

No active visual cortex could be found in TN in response to a range of visual stimuli in a series of imaging sessions, including different sessions of retinotopic mapping. Because it was impossible to control his fixation, one could not be certain that absolutely all visual cortex had been destroyed or inactivated. Nevertheless, it is a highly reasonable surmise that this was so given the consistently negative imaging

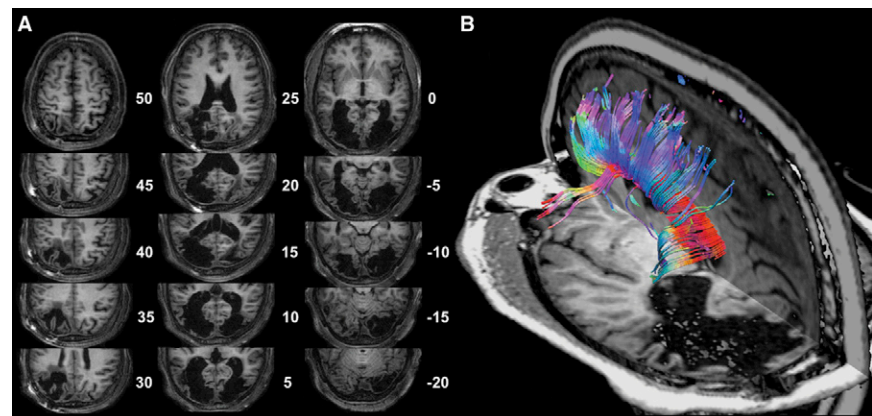


Figure 1. Anatomical description of the lesions in TN.

(A) T1-weighted MRI (axial view) showing TN's lesions and confirming bilateral destruction of the visual cortex (Talairach *z*-coordinates are given; left is left, right is right). (B) Fibers of the corpus callosum (CC) in TN (view from left-posterior). While seed points were placed in the entire CC, only fibers originating from the genu and body of the CC were found. In the splenium, no callosal fibers were detected. Only infero-frontal running fibers could be delineated, which do not belong to CC.