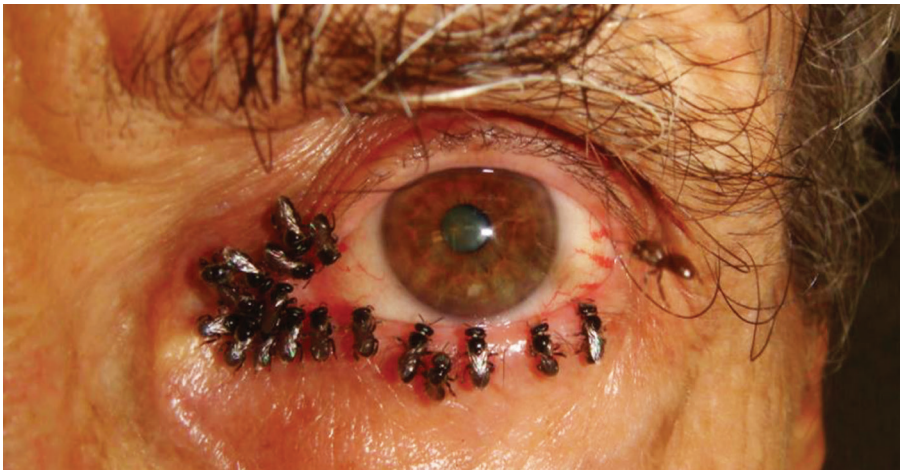
All photos by Hans Bänziger



Fast Food
Tear-drinking Bees in Thailand

by M.E.A. McNeil

"It started accidentally, as many discoveries do," said Hans Bänziger. The Swiss entomologist spoke recently one early morning from his home in Thailand where he is a professor at Chiang Mai University — the interviewer an evening and a continent away. "I was out there in the tree crown," he continued, the scope of normal behavior already beginning to broaden. "I wanted to know what would pollinate a liana." When a tiny insect landed on his eye, it brought a more insistent question: "What is this? First one came, and then after some time, two came and then four. And then an increased number."

His voice was incredulous — still. "How is this possible? It cannot be by chance. Is it possible that they are informing others, bringing others to the tears?" He knew that there are flies and moths that take tears from mammals, but only for themselves. "I caught these things in a film canister that I held against my eye." His voice was again incredulous. "It was bees."

No stranger to tear-drinking insects, as lachryphageous (tear-drinking) moths were the subject of his Ph.D. dissertation, he researched what was known about the phenomenon in bees. He knew that since 2000 there had been substantial advances in stingless bee research. But these bees were "not known at all. It was a problem, what species they were. That is how I slipped into mellitology."

As a boy, Bänziger collected butterflies and, as a young student at the Swiss Federal Institute of Technology in Zürich (ETH Zürich), he won a UNESCO scholarship to study insects in Southeast Asia. "I went to Thailand without knowing much about the place except that it was in the tropics and there was high biodiversity of insects I would study there." He got a request from a Swiss entomologist to collect specimens of moths that frequented the eyes of various animals in Thailand and Africa. Bänziger succeeded in collecting more of the tear-drinking moths than had previously been found, including many new to science. With a new grant to work in Malaysia, he discovered a moth species that sucks the blood of animals, as horse flies and mosquitoes do. He subsequently wrote a book on the subject, "Vampire Moths."[1]

Continuing his research throughout Asia, he found some 100 species of nocturnal moths, and identified some 30 new insects in Thailand, where he eventually settled. It led him to a curiosity about pollination, particularly of rare orchids. That is what brought him up into the forest canopy to observe foraging insects the day he first captured the tear-drinking bees.

He began by identifying the two species of bees that foraged on his tears. "It was not so easy to distinguish them. Behaviorally I did not find any difference. Fortunately, a famous American mellitologist, C.D. Michner, helped me." *Lisotrigona cacciae* and *L. furva* are stingless bees that vary slightly in size, their miniscule heads from 1.05 mm to 1.41 mm in width. Interestingly, length is an unreliable measure because it is dependent on the crop fullness of the telescoping metasoma, a phenomenon related to the advantages of this evolutionary adaptation in foraging.

"I thought the best way to find out about these bees was to mark them." It was not an easy task, because, un-

A Drepanid moth drinking tears from the eye of H. Bänziger in a self-portrait. The moths use the tears individually, not to nourish their colony as the bees do.

At top: *Tiny* Lisotrigona *bees forage on tears from the eye of entomologist Hans Bänziger in Thailand.*

Lisotrigona *bees forage for pollen separately from those that forage for tears.*

like flowers, the eyes of mammals are not stationary. So it was that Bänziger's curiosity led him to become both researcher and forage source. "I presented myself to the bees," he said. "Nobody proposed or suggested it. I was just interested. Occasionally, I had gotten used to myself being sort of a guinea pig with these moths, the insects I was used to naturally getting at my eyes."

He first set up three wilderness sites in northern Thailand in 2013 and 2014 — choosing two on Mount Suthe in deciduous forest, one with open canopy, the other densely shaded, and another at the foot of a limestone rock base dominated by bamboo. To eliminate as many variables as possible, he wanted to study the bees in an isolated environment. There was perennial water available from streams or pools at all the sites, and he added a basin during the dry season at the third. This was to help answer the question of why the bees were foraging on tears when water was available. It took a steep hike of over an hour to reach the first site.

To keep track of the bees, Bänziger attempted to mark them. He trimmed down the finest available brush and chose brightly colored waterproof paint: red, white and yellow. "Blue and green are more difficult to distinguish for males like me," he remarked. He then attempted to mark bees that he captured, but they were so agitated that it was impossible. They did not become still enough for him to land a spot of paint on them until they settled to drink on his eyes, so that is where he had to mark them. "Having glasses, I had to push them off a little bit, to work between the glasses and the eye. I was able to put a little drop on to what you normally call the thorax, the mesosoma technically speaking." This he did with his right hand, the left one holding a flashlight to illuminate the process, viewed in a concave mirror. "Working in the field while they were sucking at my eyes, I marked only one in two to four attempts."

Swiss entomologist Hans Bänziger in Thailand marking Lisotrigona *bees that are drinking tears from his eyes. The bees and their behavior, discovered by Bänziger, are the smallest in Asia, about two mm in length. He is holding a very fine brush under his glasses and watching the bees in a mirror on his backpack. He has been able to observe the return of marked bees to determine that they are foraging for the nutrition in tears for a nest rather than simply feeding.*

"In just 10 minutes the first bee came back. It was extremely exciting. But not only so, the bee came back, and back, and back. That bee came back over 70 times." His voice was incredulous still. "Until I was too tired. Interestingly, even overnight, the following day, the color was there. The bees tried to nibble it off, reduced in size, but still recognizable, so I could see that even the following days some bees would come back. I only marked one or two bees per day. That was very unusual. Mostly it is dozens or hundreds to make statistical analysis, which I couldn't do in this case because the follow-up of more than two marked bees was difficult when many others were sucking at the same time or continuously arriving and leaving.

"A good thing is that these dots were never the same, sometimes a little too large and on the head so it was not only the color but also the shape that would help me know that it was this very same bee returning. Sometimes when I came back, my wife would say, oh, you have some paint on your eyelids.

"Nobody had seen this," he continued. "Bees that would pester or disturb people who were rearing bees were known, and it was also known that they like to take sweat. There is a sweat bee which is different. People thought they just casually went to the eyes, that it was accidental, but I could see that it was intentional, they were looking for tears."

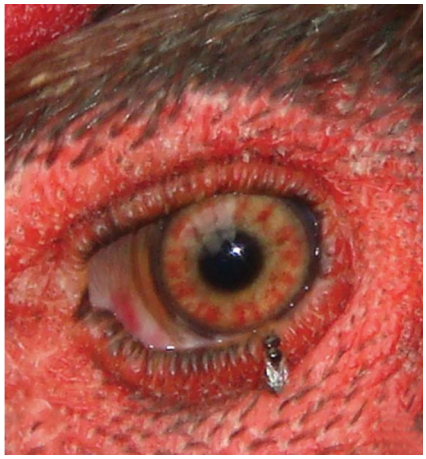
He went daily for 21 days to one site and at least once a month to the two others. Arrival of the first bee of the day took one minute to well over three hours, but once that bee left, the increase was exponential. Between the two species, the marked bees visited to drink from his eyes an average of 30

times — with every visit charted and reported for a scientific paper. He observed four vantage spots where the bee extended her proboscis into the tear trough between eyelid and eyeball: the corners of the eye and the eyelids, with the outer corner and upper lid much less frequented. On the upper eyelid a forager caused appreciable discomfort because the bee had to grasp the lid to ride it. "I could not refrain from blinking and had to dislodge the tormentor," he wrote.

Observation time had to be adjusted to the weather conditions for the three seasons in northern Thailand, roughly described as hot, wet, and cold. The most activity occurred during the hot season, somewhat less during the rainy season, and least during the cold season. However, tear-drinking occurred throughout the year, except during heavy rain, which only temporarily paused it, and temperatures below 22°C (71.6°F). Note that smaller species have a larger body surface relative to their body mass than larger species, hence they are more exposed to chill and will leave the nest at a higher temperature to reduce the risk of under cooling.

Tear drinkers could congregate, even landing on one another or sucking in a dense, mixed species cluster, but he saw neither inter nor intraspecific antagonistic behavior.

Bänziger could identify an inexperienced forager by her zigzagged approach to the eye. As she became increasingly familiar, she arrived in a relatively straight flight, slowed down and landed on the lower eyelid, or less often on adjacent skin around the eye, and crawled to the eyeball. The most experienced collectors would fly in low and land very gently below the cilia or at the inner corner of the eye and then advance to where their proboscis could reach the tears accumulating in the trench between lid and eyeball. They crawled by using only their tarsal soft arolia pads with the claws contracted — as has been described for honey bees crawling on smooth vertical surfaces and unlike the bothersome tarsi and claws of inexperienced drinkers. These veterans caused only a faint tickling. Sometimes the landing was so gentle he just barely noticed it.



Tear-foraging Lisotrigona bees on the eye of a chicken.

The proboscis, about a millimeter long, is very fine and soft. Once a bee stopped crawling and started sucking, "I felt rather little or no discomfort. On occasion I had to check my mirror to see whether she was still there or not."

At times, congregations of bees on his eyes could be unpleasant to unbearably irritating to him, "in which case I collected the bees for counting and release at the end of the session. I interpreted this tingling as mainly mechanically induced" — like the pinching of his upper lid. But other instances of discomfort may have been chemically-based markers. "Often the feeding spot felt burning while the bee was sucking or shortly before leaving, the sensation continuing for a minute or so after she left, indicating that a substance had been deposited, possibly a secretion by the mandibular gland. Further, she often did not readily fly off but remained a second or two while moving her antennae and forelegs, sometimes slightly turning her head to the right or to the left. Then, on leaving, she caused a characteristic sensation to my lid. All these movements may be for possible scent-marking." Nothing was observed of a sent plume or waggling, spinning or extruding droplets as observed in other bees. "This tingling became a prurigo after more bees had been sucking, and at times I could not restrain myself from vigorously persisting guests."

Although the bees were never seen laying a scent trail, they appeared to respond to the visual presence of another bee. "At times a worker mistakenly settled on my temple where I have a dark mole the size of a *Lisotrigona*, often joined by further misguided foragers."

Bänziger remained on site from 1.5 to 11 hours on each visit, offering his tears, identifying the same bee as many as 144 times in one day. He found that more than 300 collectors could be involved in the course of a day, a maximum of over 30 at the same time, with foraging lasting as long as 10 hours. "Some days the bees were too pestiferous to bear them for more than a couple of hours."

The bees imbibe flowed-down tears of an elongated tortoise.

Water was always easily accessible at the study sites, but it was sucked only by other stingless meliponines, many hymenopterans and other insects, but not *Lisotrigona*, which were never found at water from the streams, wet sand or water basins. Even after sustained rain and drenched habitat, it was obvious that the little bees at Bänziger's eyes were seeking something beyond water. The uptake of salts and other minerals from sweat is well known, but lachrymation is special for having a high protein content — over 200 times that present in sweat. Although pollen is much richer in proteins and lipids, tears can be a superior food source for several reasons:

Pollen grains are protected by hard exine walls that hamper digestion. The proteins in tears are naturally dissolved, and digestion can proceed promptly: fast food. Pollen harvesting is energetically more costly than tear collecting, considering the time airborne and transferring pollen. In comparison to tears, which are secreted continuously, pollen can be limited. Tears also have antiseptic properties; for example, in human tears about a quarter of the total protein content is lysozyme and other components that have antibiotic properties.

None of the bees on Bänziger's eyes carried a pollen load. A few had pollen remnants, which he presumed were either a result of age polyethism from previous pollen collecting or from contacts with nestmates observed foraging on lichi flowers in the canopy. In any case, it appears that there is division of labor where some workers fill a specialized function, tear collecting. *Lisotrigona* can some-

time forage on sweat, but less often, and in rare cases, blood. He speculates that they may also collect dew from the canopy.

Tear harvesting requires a number of adaptations, which Bänziger lists as the ability to find a live vertebrate host,[2] to approach rather than flee, pursue if it walks away, locate its eyes, approach initially with a horizontal zigzag flight (unlike the vertical zigzag of lachryphageous flies), gently land, drink tears for up to six minutes, remain when being shaken by the host's blinking, hang on if it runs, and persist if chased off. "All of this could hardly be in more plain view of the victim and on its most sensitive organ," he wrote.

He was curious to know how far the little bees were flying, and devised two experiments. To measure forage range, he walked slowly away from the study site with several *L. furva* circling his head until the last bee discontinued pursuit. To discover the homing range, he ran "resilently" with a marked tear-drinker on his eye and noted when she flew off. If she was able to return when he was back at the site, he concluded that she was at a distance at which she could reorient herself. He estimated that the maximum foraging range of *L. furva* is not less than 210 m and possibly 400 m or more, with a homing range of 425 m to 600 m.

He writes that *Lisotrigona* must have foraging and homing capabilities greater than those in larger pollen and nectar foragers, possibly as a result of adaptation to ephemeral and mobile food sources. He remarks that hosts within *Lisotrigona's* range can linger, as some mammals and birds can be nest-bound for weeks or regularly visit, often in flocks, salt licks, water sources and trees in fruit.[3]

At the end of each day, to assess the number of visiting bees, he captured a sample from his eyes in a film cannister (an artifact perhaps unfamiliar to a subsequent generation). When the foraging bees were so numerous that they could not fit in the space around his eyes but continuously attempted to land, fell off, and resumed circling his head, they were caught with a net at 10-20-minute intervals. They were lightly narcotized with ethyl acetate to give him an approximate count and released.

Try as he would, Bänziger could not locate a nest at his three early study sites. It was not surprising because, when he later located nests elsewhere, they were in extremely small sandstone fissures.[4] His questions remain: What's going on in there? Are the bees transferring the tears by trophallaxis, storing them, mixing them with nectar or what?

Entomology department, Faculty of Agriculture, Chiang Mai University in Northern Thailand, where Bänziger has an appointment for part of each year.

And what could have led to such specialization? Surely it would be much easier to collect salt from human skin as well as pollen, as many meliponines do. One theory is that lacrophagy may have originated in association with early humans, who lived in limestone caves some 100,000 years ago. Interestingly, the bees often nest in cavities in limestone rock faces. As humans are mammals that sweat in notable amounts, foraging might have begun as sourcing water from sweat and then tears in dry regions. "Nowadays *Lisotrigona* may have few chances to repeatedly snatch tears from sensitive 'civilized' humans — some masochistic scientists excepted," said Bänziger wryly.

He has reflected on the potential for viruses to be transferred through the oracular surface, and assessed the potential as low when he began the project. "I felt that the risks involved were to be solely my own." The more recent detection of the Zika virus in tears has led him to consider that he "may have been doing something dangerous."

He continues his interest in *Lisotrigona* in pollination (particularly of some rare orchids), oversees a doctoral student studying meliponines, and is active in significant ecological projects. He has published some 90 scientific articles and the aforementioned book. He still has an air of astonishment when he discusses the tiny tear-drinking bees. "The eye is the most unorthodox ecological niche where minuteness and gentleness is a precondition."

Footnotes

1. **Bänziger, H. 2021.** Vampire Moths. Behaviour, Ecology and Taxonomy of Blood-sucking *Calyptra*. Natural History Publications (Borneo); Kota Kinabalu, Malaysia; viii+232 pp.
2. **Bänziger, H. 2018.** Congregations of tear drinking bees at human eyes: foraging strategies for an invaluable resource by *Lisotrigona* in Thailand (Apidae, Meliponini). Natural History Bulletin of the Siam Society 62(2): 161–193.
3. **Bänziger, H. & S. Bänziger. 2010.** Mammals, birds and reptiles as hosts of *Lisotrigona* bees, the tear drinkers with the broadest host range (Hymenoptera, Apidae). Mitteilungen der schweizerischen entomologischen Gesellschaft 83: 271–282.
4. **Bänziger, H., S. Phumikong & K. Srimuang. 2011.** The remarkable nest entrance of tear drinking *Pariotrigona klossi* and other stingless bees nesting in limestone cavities (Hymenoptera: Apidae). Journal of the Kansas Entomological Society 84(1): 22–35.

Mea McNeil is a journalist and Master Beekeeper. Her new novel "Bee Club" is available from Nervous Ghost Press: **https://www.nervousghostpress.org/product-page/bee-club**