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HUMANS AS BEES

While in the USA the large-scale transportation of millions and millions of bees from one plantation to the next is impressive, there is another, very different method of pollination to marvel at in the People's Republic of China. In some parts of the country, two-legged pollinators with cotton swabs, brushes, homemade tools, and ancient medicine flasks filled with pollen abound. Something that we would consider almost unimaginable is very much a reality in parts of China: fruit trees that are pollinated by hand. Bees have not been made redundant because we have discovered better ways to do their job, but in some places, there simply are no bees to pollinate the apple trees. People wanting to harvest fruit in such places have to think of other ways to pollinate.

To see the human pollinators at work, Markus Imhoof and his film team traveled to Maoxian at apple-blossoming time. This was no easy venture, particularly for visitors from the West; the roads and bridges leading to the mountainous valley that winds its way to Tibet were ravaged during the devastating earthquake of 2008 and, to all intents and purposes, it is out of bounds to foreigners. The filming team of *More Than Honey* did, however, succeed in traveling to the high valley and were shown on-site how humans using their own materials copied a process that nature had perfectly equipped insects to perform.

The technique is as easy as it is painstaking. The pollen is collected by rubbing two blossoms against each other and catching the falling pollen in a newspaper; the pollen is then carefully dabbed onto each individual blossom. Improvised tools are used for this, mostly cigarette filters stuck onto a pencil or small bundles of chicken down attached to a stick. Every tree has to be visited and dabbed a number of times as the blossoms of one tree are never receptive all at the same time.

This lack of synchronicity is natural and serves a purpose. As a rule, the male and female organs of a blossom are close to each other, which could lead to self-pollination and limited genetic variability in future generations. In order to avoid the dangers of inbreeding depression, as this is called, and along with it a decline in resistance or fertility, pollen and the receptive stigmata develop at different times. So, when a bee brushes against ripe pollen in a blossom and then against the stigma of the same blossom, there are no consequences as the stigma is not yet receptive. However, the majority of stigmata in the neighborhood are receptive at this time.

The image of not worker bees but human workers going from blossom to blossom pollinating in the Sichuan province presents a horrifying glimpse of a future when bees may no longer be around. The painstaking work of the Chinese fruit farmers is the result of a situation that has nothing at all to do with bee mortality. The practice of using humans as pollinators has been widespread and well known for some time, as the anatomy of the small and most common honeybee in all of China, *Apis cerana*, does not suit all species of apples that have been cultivated in Maoxian since time immemorial.

This is why, even in the times of Mao Zedong, pollen was transferred by hand. The process was apparently documented in a contemporary movie sequence showing a young couple in the branches of adjacent fruit trees in full bloom, singing a love song while white blossoms swirl against the blue heavens. Since then, the ministry of agriculture has decreed that the Japanese Fuji apple trees should replace all the trees that require hand-pollination in apple plantations. The blossoms of the Fuji trees have shorter pistils and can easily be pollinated by the native Asian honeybees.

Markus Imhoof met a number of Chinese experts who had more confidence in hand-pollination than in insect-pollination. Are they right? As part of a state-aided project at the Agricultural University in Beijing, Professor Shi Wei researched and compared the pollination capacities of bees, bumblebees, and humans, something she had previously done in Kenya and Sweden. Humans landed far behind both types of bee in third place.

Bumblebees achieved second place most of the time but first place for some species. People interested in growing tomatoes on a large scale in greenhouses buy industrially produced bumblebee nests and hang them in the greenhouses. Companies offer nest boxes that can accommodate up to three colonies. Time-controlled lock-in systems using valves at the flight openings allow bees to enter but not to leave as there are some occasions, for instance when insecticides are being used, when the bees have to be kept safely in the hive. However, when compared with honeybees, the bumblebees do not fare as well in pollinating most blossoms. Strawberries, where each individual blossom has to be visited up to six times and with a specially choreographed circular landing, are very often deformed if pollinated by bumblebees; the same applies to apple and pear trees, which then tend to bear deformed fruits.

On the whole, honeybees retain first position in the pollination rankings, but whether there will be enough healthy colonies to maintain this ranking is uncertain, even in China. Scientists there who spoke to Markus Imhoof off-camera blamed the massive intrusions of pesticides for the dearth of bees in many of the fruit-farming areas of the huge country.

Hand-pollination has become so professional in some regions of China that the growing demand for pollen has led to the creation of a number of small

businesses dealing in pollen. People like Zhang Zhao Su, from Wafangdian in northeastern China, make a living by harvesting, purchasing, transporting, and selling pollen. In her home in northern China there are traditionally large apple plantations but no longer bees, as most of them have fallen victim to pesticides or taken flight to escape them. Because of the harsh climate in the north and the very short blossoming time—only five days—fruit farmers rely on pollen from provinces two thousand kilometers (1,242 miles) to the south where the trees blossom six weeks earlier. This pollen, however, is not brought by bees but by Zhang Zhao Su, who travels with her small team to Taiyuan in Shanxi province in spring to buy apple blossom in bulk.

> It takes two days and two nights to drive there with two drivers taking it in turns to drive. As soon as we arrive we rent a large room where we can dry out the blossoms. When we have enough we start to process them. We cut off the pollen, the individual processing stages are, of course, a trade secret. Then we head back north. We have a fridge in the car which we plug into the mains when we stop for a rest, that way we are sure that the pollen stays fertile. When trees here in the north start blossoming we sell the pollen to fruit farmers.

It would be wasteful for the human propagators to use the concentrated pollen as bees do, so the pollen is cut with cornmeal, also offered for sale by the pollen dealer. Zhang Zhao Su packed her wares into five-gram (0.17 ounces) bags and sells them to retailers for CNY5 (roughly US$0.80). These are displayed right next to the agricultural toxins that are causing the bees all their problems.

Pesticides are a massive threat to bees in both the East and the West. The Asiatic *Apis cerana*, unlike the European *Apis mellifera*, copes very well with that great adversary of the honeybee, the dreaded *Varroa* mite. The smaller relatives of the European honeybees that have developed since the last Ice Age have a number of defense mechanisms against mite infestations at their disposal. Unlike the European strain, the bees from East Asia can smell when

their brood has been infested with mite eggs. They seal off the cells of infected offspring with such thick lids that the young bees cannot hatch and so die together with the *Varroa* mites. In the course of evolution they have devised a kind of euthanasia for the collective health benefits.

Varroa destructors have only appeared in Europe in recent decades. To find out how this mite was able to conquer almost the whole world we have to follow the tracks of the European honeybee, which spread around the world as a result of European emigration over several centuries.

At the end of the eighteenth century, a tsarist officer named Arshenevsky asked his sister in Kiev to organize the transport of twenty-four colonies of Ukrainian bees to his post, at that time in eastern Kazakhstan. They survived the four-month journey but succumbed to the Central Asian climate. The uniformed "bee fancier" then acquired colonies from the Urals. This relocation proved a success, and the bees, a strain of European honeybees, spread

eastward in subsequent years via the Baikal region (1851), finally reaching the Pacific coast. The Trans-Siberian railway (1904) provided a link between East Asia and the western side of the huge Russian Empire and with it many Ukrainian emigrants—and their honeybees. The European strain, of course, came into contact with the native Asiatic honeybees that in past millennia had managed to learn to live with the tenacious parasitic mite. *Apis mellifera*, on the other hand, had no chance; they encountered *Varroa destructors* unprepared. The European honeybees simply hadn't had the time to develop strategies against what was for them an unknown parasite.

But there was also a second important distribution route, this one from the opposite direction. After European settlers had established *Apis mellifera* in America in the fifteenth century, the bees eventually reached Japan in 1876, where they met up with a subspecies of Asian honeybees that carried a special subspecies of *Varroa* mites. The newcomers naturally became infected. At the beginning of the 1970s, Japanese emigrants in turn brought their bees, now infected by *Varroa*, back to America. The infection spread from Paraguay to the whole South American continent and within a few years had reached the US west coast.

The mites arrived in Europe in the 1960s as European beekeepers imported Siberian bees whose honey production was said to be far superior to that of European bees. This soon proved to be a fallacy, but the flourishing business in Siberian bees was unstoppable. The imported bees, together with their parasites, had long found their way to European beekeepers.

The mite was first described in Bulgaria in 1967; four years later, *Varroa* appeared in Czechoslovakia, as it then was, in 1976. By 1977 it was in Germany; ten years later it had made its way back to the US by air, where a short time later it met up again with its infected relatives from Japan.[1]

Varroa is considered to be one of the main causes of the continuing mass mortality of honeybees in Europe and the USA, and, as the film team of *More Than Honey* discovered, the Chinese beekeepers who work with *Apis cerana*—bees that can coexist with *Varroa*—feel compelled to keep the mite away from their hives with the help of formic acid. Although *cerana* are able to fight the

destructors on their own, Chinese breeders find that the hives are freed from parasites more quickly with the help of formic acid.

While researching the documentary in southern Sichuan, Markus Imhoof also met migratory beekeepers selling their honeydew honey on the side of a busy road. They openly admitted that they no longer place their hives in areas of intensive farming south of the mountains. The losses caused by the vast amounts of sprayed pesticides were simply too great. It is, so to speak, a form of industrial action by beekeeper and bee; the consequence is that in the meantime people have to pollinate the trees.

As Imhoof was about to buy some of the migratory beekeepers' wares, he was warned by his Chinese driver that he shouldn't be fooled by the idyllic site with the forest as a backdrop, as Chinese honey generally contains many harmful substances and, particularly in this region, is mixed with sugar syrup.

In the EU, the importing of Chinese honey was prohibited in 2002. The concentrations of chloramphenicol were too high, which suggests that high dosages of antibiotics were being used to counter American foulbrood. The ban was lifted in 2004 after the Chinese prohibited producers from using antibiotics, but the bad image of honey from East Asia remained and was reflected in market misgivings.

There were and are ways for the Chinese honey exporters' products to reach the supermarket shelves. The standard method is blending, meaning that contaminated honey is mixed with other kinds of honey. The act of blending is legal and even appears on the labels: "A blend of honeys from EU and non-EU countries."

In order to sneak honey of dubious quality or of allegedly suspicious origin through the EU security barriers, the suppliers have to eliminate traces of pollen or elements of pollen, which usually remain in the end product. The specific composition of these elements provides information about whether a honey (or its diverse blended compounds) originates from Argentina, South Africa, the Lüneburg Heide, or even China. For imported honey, there are no binding lower limits to the amounts of pollen that a tested honey batch has to contain. When the inspectors detect noticeably low levels of pollen, they

may suspect that someone is deliberately trying to hide the country of origin—erasing the "fingerprint" by filtering out the pollen—but nothing more. They make their judgment, suspicions notwithstanding, only on the measurable pollens. If, for example, one-third of a batch of honey consists of high-grade Hungarian acacia honey with a natural proportion of pollen, the other two-thirds being global market honey with barely detectable amounts of pollen, the test report will then identify it as honey from Hungary. The unusually low pollen content of the honey blend clearly points to adulteration but the findings of the pollen analysis stand. And they indicate that, in this case, the honey is from an unproblematic part of the world.

For critics and experts in this area, it is very difficult to imagine that such a loophole in the testing procedure is not the result of specific lobbying. Walter Haefeker commented that:

> There is no way that I want to say that imported honey is under a blanket of suspicion, after all 80 percent of the honey that we eat in Germany comes from other countries, but I have always been a bit concerned about what the lab specialists from the testing institutes tell me about being unable to find the countries of origin after analyzing pollen from large amounts of imported honey. And honey producers from India and China proudly declare that they produce "honey" that has absolutely no connection to a single bee but is made from various types of inverted sugar. And bear in mind that they were talking about honey that they had successfully guided past the EU inspections.

Not only does China produce the bulk of honey consumed globally, but it is also the leading worldwide producer of royal jelly. Markus Imhoof, in the run-up to filming, visited a factory near Hangzhou that produces 30 percent of Chinese-produced honey and 70 percent of its royal jelly. The modern building in which the royal jelly produced drop by drop by nurse bees is processed looks like a high-security wing. This is hardly surprising as it harbors a substance that is both precious and correlatively expensive, and that has to be shielded

from any form of contamination with none of it wasted. If we consider the laborious production process, it is all the more astonishing to see the size and number of stainless steel drums into which the substance is poured and stirred by workers who are dressed and masked like surgeons in an operating room.

In order to maximize yields of royal jelly, the manufacturers have found ways of making the bees produce far more of the precious substance than they would usually do in the hive. If one colony had several queens laying eggs instead of a single queen as found in nature, the output could be increased many times over. Normally a queen doesn't tolerate any rivals in its colony—it kills them. In the Chinese royal jelly factory they cut off a mandible, as the queen can only use its lethal sting after having firmly gripped its rival with its mandibles. After such treatment, seventy queens can lay about two thousand eggs apiece in one hive, giving a daily total of almost 10 million eggs.

In the first three days after hatching, the larvae are transferred to artificial queen cells and subsequently placed in a nursing colony from which the queen has been removed. In a bee colony, the absence of a queen constitutes an acute emergency—without the egg-laying queen a colony would die within a few weeks. The nursing colony now feeds not only one queen larva but also all the artificially implanted queen larvae. A robust nursing colony can be expected to support fifty feeding areas. Once the maximum royal jelly production has been reached in the hive after a few days, the young queen larvae are removed and the valuable larval food taken from the cell. A strong nursing colony can produce half a kilogram (around a pound) of royal jelly per season.

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Royal jelly is particularly valued in traditional Chinese medicine for its supposed life-prolonging properties. Its reputation can probably be traced to the observation that queens, which eat nothing but royal jelly, can live to the age of eight while the other bees die after five weeks. Whether you can prolong your own life by consuming it is questionable, but at prices of up to 130 euros per kilogram (almost US$82 per pound) you are likely to die impoverished.

The scope of its possible applications sounds impressive. Royal jelly preparations apparently increase mental and physical capacities, and followers of alternative medicine in particular swear by it. Even the enterprising cosmetic industry has discovered the substance.

The royal jelly is a profitable sideline, although it's almost impossible to confirm the figures. China, which apparently makes 90 percent of the royal jelly available on the market, produces between 2,500 and 3,000 metric tons (2,755–3,306 short tons) annually. With world market prices between 100 and 130 euros per kilogram (around US$63 to US$82 per pound) this means a volume of trade of up to 390 million euros (US$540 million) per year for these global market leaders.

But it is not only royal jelly that has fascinating properties. Apitherapy, which involves using bee products for medicinal purposes, has had some reported successes. Manuka honey from the blossoms of the manuka myrtle, *Leptospermum scoparium*, originating from New Zealand, is enjoying increasing popularity. The Maoris have long known of the disinfecting properties of this honey and long used it externally for wound healing. In 2011, manuka honey, under the brand name of Medihoney, was approved as a medical product. Even though most bacteria cannot grow in honey, this honey is additionally sterilized by gamma irradiation. Detailed studies about the effectiveness of manuka honey have yet to be completed, but it is already certain that this honey has far higher levels of methylglyoxal than other available honeys. Methylglyoxal is formed in the honeycomb as a sugar degradation product and has been shown to have antibacterial effects. This bacteria-killing potential, which is also present in food-grade honey, allows the bees to store the viscous mass in the hive in the first place.

Whether for its healing effects or its tastiness, honey remains a very special sweetener—long after the discovery of how sugar can be manufactured from sugar cane, or more recently from sugar beet. You could even claim that it is a substance with cult potential.

While globally bees are becoming less common in the regions shaped by agriculture, beekeepers are experiencing a renaissance in cities of all places.

For a number of years, metropolitan areas like London, New York, and Tokyo—famous for skyscrapers, smog, and noise but not at first glance the ideal refuge for bees and other insects—have been finding increasing numbers of supporters of a phenomenon called urban beekeeping.

It all started in Paris. In the mid-1980s, a retired opera house prop man named Jean Paucton began placing beehives on the roof of the Palais Garnier opera house. Initially it was just a small, private indulgence that brought in a good additional income. Paucton sold small jars of his Opera Honey for 4 euros (around US$5.50) to the gift shop in the foyer of the opera house where they sold for 14.50 euros. The bees found nectar in the abundance of blossoms in the city parks, from window boxes on balconies, and from linden trees and acacias, yielding some 450 kilograms (992 pounds) a year. His experiment received a lot of attention after the publication of photographs by *Earth from Above* photographer Yann Arthus-Bertrand in the popular magazine *Paris Match*. Since then, Paucton has been inundated with requests from photographers and camera teams, journalists, and groups of visitors from around the globe.

Today he uses this interest to campaign not only for his particular form of urban beekeeping but also for the general good of bees and a nontoxic environment. He claims that his losses within the colonies amount to roughly 5 percent, whereas traditional French beekeepers in the countryside have to bear losses of almost 50 percent. He places the blame firmly on conventional agriculture: "There just aren't any proper farmers anymore, there are only agricultural companies and they all use pesticides."[2] Paucton sees his success, as measured in honey yields and the health of his bees, as indirect proof that agricultural toxins are a main cause of the worldwide death of bees because, at least in this respect, cities are as good as free from toxins. Walter Haefeker thoroughly agrees with him: "In the meantime, bees in the cities are much better off than those in the country."

One of the reasons for this is the biodiversity that has now become a feature of urban areas. There are apparently more species of plants thriving in Berlin than in all the agricultural areas of Germany. "The city has become a

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mixed forest," says the evolutionary biologist Josef Reichholf. "Even alluvial forests with the richest biodiversity can't even begin to compete with the diversity of trees in large cities."[3] This might be explained by the fact that alluvial forests are characterized by tree species that can adapt to varying water levels, whereas trees in urban environments have no need to adapt to dramatic variations in water levels. And gardens—at least for the enlightened modern gardener—are no longer products of uptight adherence to planning, with austere right angles and featureless lawns, but instead offer more diversity and are planned more around the needs of fauna.

In the cities, the annual average temperatures are higher by some 2°C (an increase of 3.6°F), which also helps the bees. The warmer climate means that the foraging season is somewhat longer; in addition, the winters are milder. Concerns that the honey from urban areas could be contaminated by exhaust fumes and fine particle pollution have proven unfounded. Bees always collect fresh nectar that has not had time to come into contact with air pollutants and absorb them. Should any of the mostly fat-soluble pollutants somehow reach the hive, they bind to the wax in the honeycomb and so have no effect on the honey.

The continuing trend of beekeeping in the cities has attracted such an increase in interest that beekeeping initiatives like Berlin summt! (which translates literally as Berlin buzzes) are at the limits of their training capacities—beekeeping has to be learned. Just like the Parisian experiment, the initiative has been behind colonies being placed on prestigious Berlin buildings, such as the Abgeordnetenhaus (the state parliament building), the Haus der Kulturen der Welt (house of the cultures of the world), Berliner Dom (Berlin cathedral), and many other buildings to publicize its cause. And in Vienna, Austria, bees launch off the roofs of the Burgtheater, the Vienna State Opera, and since 2012, the gilded dome of the Vienna Secession.

There is, however, a development in the other direction that at first glance seems to be a paradox. While the number of beekeepers has begun to rise in recent years, there are ever fewer colonies. In Germany, according to the German beekeeping association, the number has dropped from around

850,000 colonies at the beginning of the twenty-first century to 700,000 today, a decrease of almost 20 percent in just over a decade.

Fewer colonies despite more beekeepers? This is less of a contradiction than it seems, as urban beekeepers seldom keep more than three colonies. Interest in beekeeping mostly translates as completing one's own natural garden, experiencing the fascinating world of bees, and attempting to redress the deficit of bees in the meadows in and around cities. Modern beekeeping seems to be more of an expression of ecological awareness and an urban yearning for nature than a lucrative sideline or a gentle pursuit for the retired, which was often the case in the nineteenth and twentieth centuries.

The relocation to metropolitan areas has natural consequences for the pollination situation in the countryside. Multitudes of small colonies belonging to the new hobby beekeepers live and forage behind houses, and in gardens, parks, and cemeteries.

In built-up areas the bees are not lacking anything, but the open countryside and farmlands, where ambitious recreational beekeepers placed their hives in the good old days, have gradually offered fewer species of plants and provisions have become scarcer. Both toxins and blossom uniformity affect bees and other insects not only in the long-term but also, in some cases, immediately. So-called harvest shock can destroy whole colonies within a short period of time. When the remaining, still fertile meadows are mown at a single stroke—providers of agricultural services have to make their expensive equipment economically viable—the supply situation inside the hive becomes precarious within hours. Sometimes an entire rural district is mown in one day. The bees react promptly and drastically; developing broods are torn from their cells so that the population of the hive reflects the new and reduced food supply situation. If, however, a hive is numerically reduced in this way, the intruders, the *Varroa* mites, quickly gain the upper hand and the decimated colony can no longer withstand them. In addition to this, thousands of insects are direct victims of the high-performance machines that squeeze liquids from freshly mown grasses to shorten drying times and thus contribute to the disappearance of bees. According to a study from the Schweiz. Zentrum

für Bienenforschung (the Swiss bee research center), between 35 percent and 53 percent of the bees active in fields during the harvest die as a result of these farming methods.

Furthermore, the increasing demands for biofuels and electricity from biogas plants require ever larger areas for cultivation; the meadows and fallow lands on which bees and other insects rely as food sources are being swallowed up by the industrialization of agriculture. This caused the German professional beekeeping association to launch a publicity campaign in the summer of 2012. Operating under the name Flower Power (they opted to use English for their name), and using sponsorship, bonus systems, and targeted subsidies, the beekeeping association hoped to persuade biogas plant owners to grow bee-friendly flowering plants and to convert these plants into energy instead of growing corn, which is causing increasingly more damage to the soil and the countryside than can be compensated for by biopower, for this purpose. The biogas industry has, to say the least, an image problem because of the fiercely deplored, featureless tracts of land taken up by corn cultivation nationwide and so maybe will be open to suggestions. Blossoming landscapes *and* power from the fields? Now that's a sweet idea.