

## **Pollinators in the urban age**

Sebastian Walter and Axel Brockmann

## Abstract

The beginning of the ‘urban age’ comes along with a worldwide decline of insects –due to human impact on the environment<sup>[i]</sup>. Especially alarming is the loss of bees and other pollinators, because of their importance for agriculture and thus for our food security as well as for the stability of ecosystems. Considering the worsening conditions on farmland, growing urban areas might function as refuges for endangered bees. In this article, we describe the situation of wild giant honey bees in the rapidly developing megacity Bengaluru (also called Bangalore), the high-tech capital of the Indian state Karnataka. Naturally nesting in the open in big trees and at cliffs, these bees use high-rise buildings as nesting sites in the city. Excerpts from interviews with citizens of Bengaluru<sup>[ii]</sup> give insights into increasing conflicts between humans and bees, but also show possibilities of coexistence.

## Authors’ profile

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After graduation in liberal arts and biology, he first investigated the neuropsychology of colour perception at New York University NYC (USA) and the Universities of Magdeburg and Giessen (Germany). He currently works at the German Archaeological Institute (DAI) in Berlin on human-animal relations with a focus on insects and the visualisation of past landscapes. Results of his artistic and scientific research were internationally presented in exhibitions and published in books and journals, among them Journal of Vision and Nature Neuroscience. Sebastian’s special interest in relationships between humans and bees in India developed during a Goethe-Institute residency in Axel’s lab at NCBS (<https://www.goethe.de/ins/in/en/sta/ban/ueb/bar/smw.html>). Email: [sebastian.m.w@gmx.de](mailto:sebastian.m.w@gmx.de)

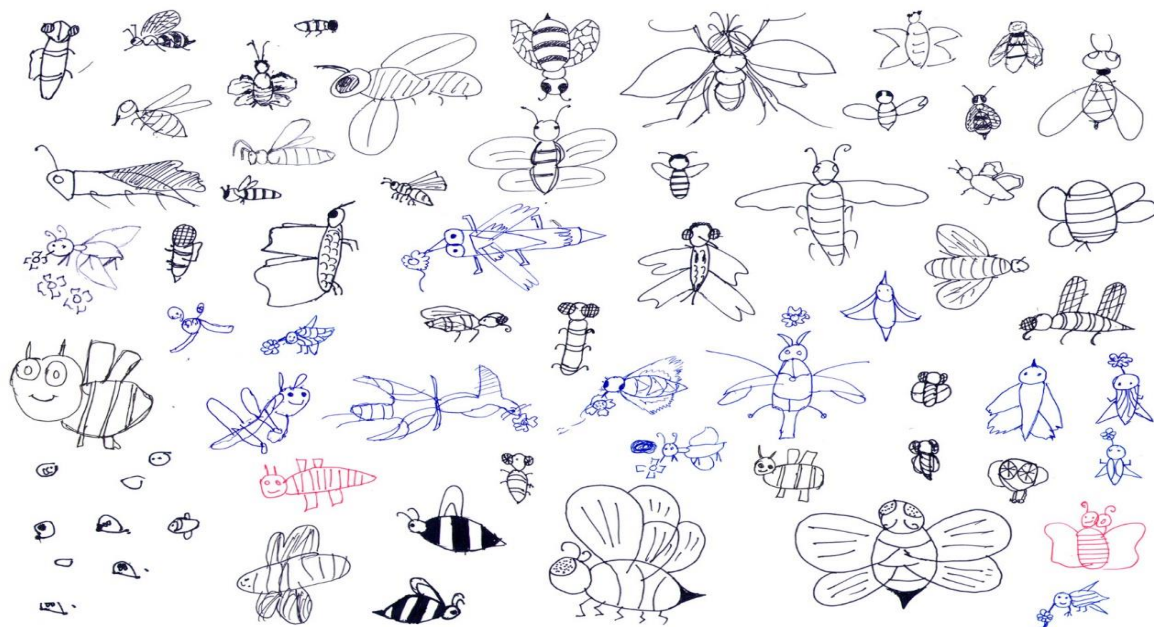
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He did his PhD at the University of Bremen (Germany), and postdoctoral studies at the University of Würzburg (Germany) and the University of Illinois at Urbana-Champaign (USA). His lab studies molecular mechanisms underlying time memory and honey bee dance communication. In addition, they have started comparative studies on the biology and behaviour of Asian honey bees including *Apis dorsata* ([honeybeelab.weebly.com](http://honeybeelab.weebly.com)). Together with colleagues from other Indian research institutions, he

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## Pollinators in the urban age



Bee drawings by children, teenagers, and adults during the NCBS Moth Day, National Centre for Biological Sciences, Bengaluru (arrangement by Sebastian Walter).

### There are many: The diversity of honey bees of India

*“I don’t have much experience with bees.” “We have seen honey bees, but don’t know anything about them. ...We are afraid of giant honey bees, they are dangerous...small honey bees will not do anything.” “...there might be many other bees, ...smaller ones, bigger ones, I’m not pretty sure.”*

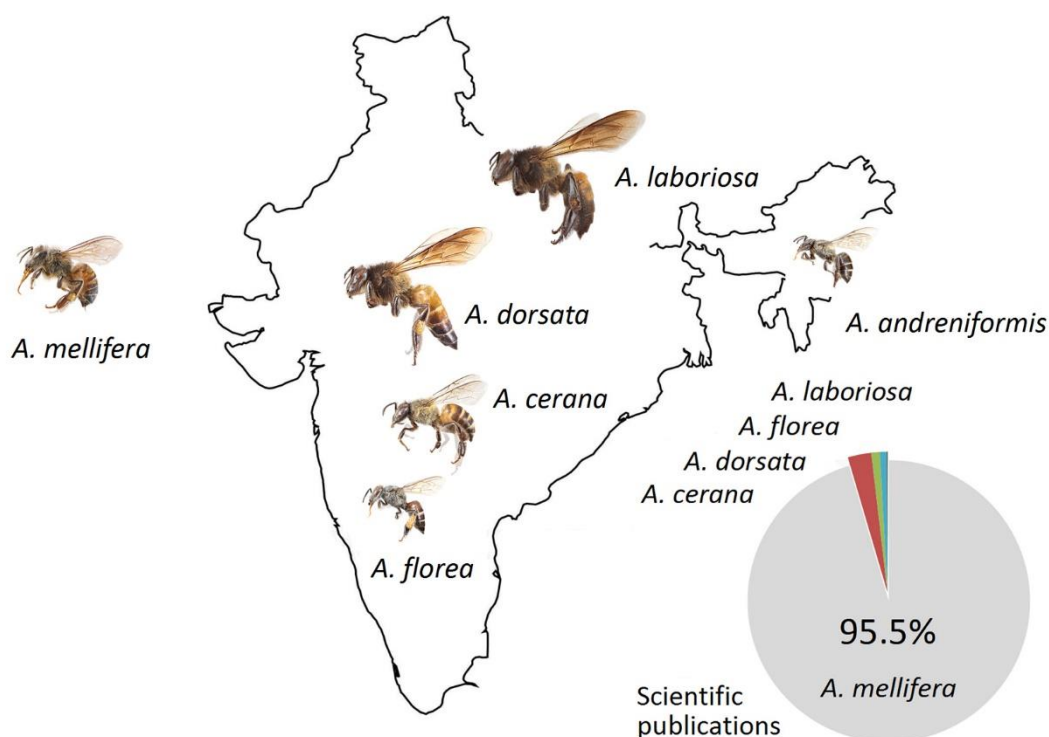
These are common answers given by people in Bengaluru when asked about bees. Most are not very familiar with bees and only have little knowledge about them, but they know that there are different kinds of bees and also different kinds of honey bees.

India is among the countries with the highest diversity of honey bee species. The scientific ‘first name’ of a honey bee is *Apis*. Conservative estimates suggest that there are nine to 11 *Apis* species worldwide, all of them native to Asia. In India, we find five native honey bees. Three of them are widely distributed: The giant honey bee or rock bee *Apis dorsata*, with big nests in large trees, at cliffs, and at buildings; the red dwarf honey bee *Apis florea*, which makes small nests in bushes and smaller trees; and the Eastern honey bee *Apis cerana*, a cavity-nesting bee (e.g., in hollow trees, termite hills or lamp posts), which is traditionally used in beekeeping. In certain regions of India, two more species of wild honey

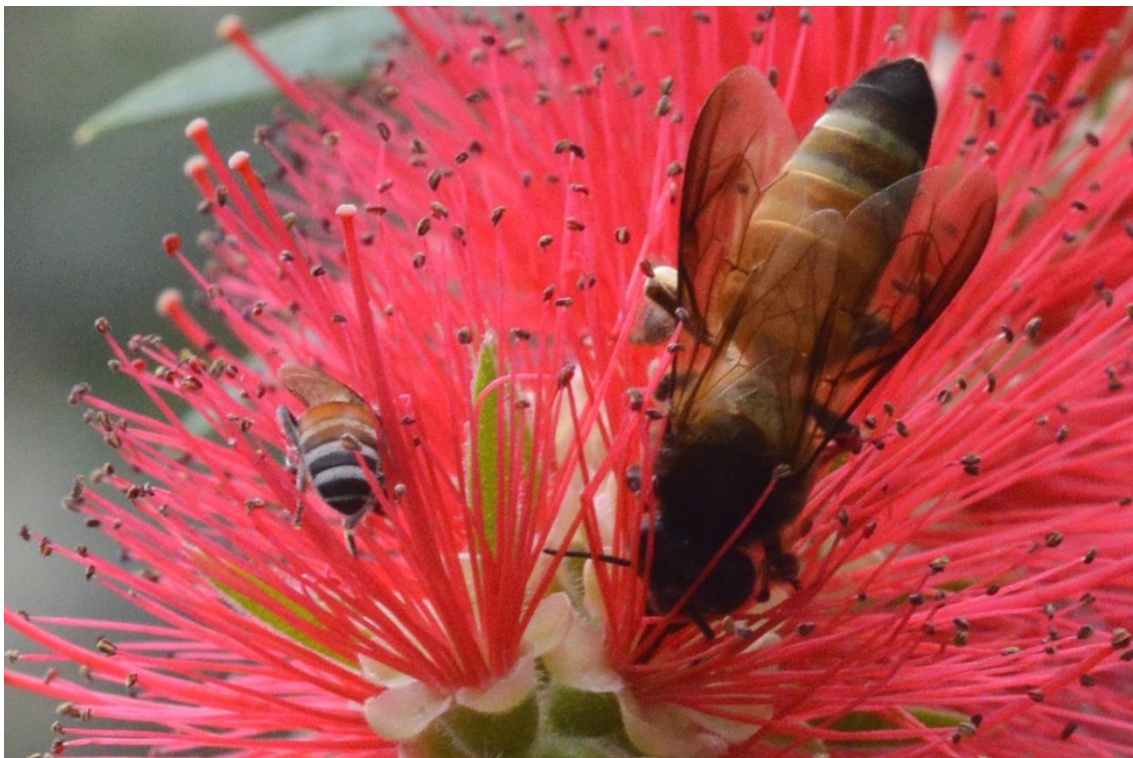
bees are found: *Apis laboriosa*, the Himalayan giant honey bee, adapted to higher altitudes, and *Apis andreniformis*, the dark dwarf honey bee, restricted to the forests in Northeastern India. *Apis cerana* as well as *Apis dorsata* are represented in India with two different forms or subspecies, of which one occurs only here<sup>[iii]</sup>.

*Apis mellifera*, the Western honey bee, native to Europe, Africa and south-western and central Asia<sup>[iv]</sup>, was first introduced to India during the late 19<sup>th</sup> century<sup>[v]</sup> and is today of special importance for beekeepers<sup>[vi]</sup>. It is also the bee that has been most intensively studied by scientists all over the world. Most of our current knowledge about honey bees and bees in general derives from studies on *Apis mellifera*<sup>[vii]</sup>.

Like the honey bees, stingless bees (scientifically Meliponini) live in colonies and produce highly valued honey. Altogether there are more than 700 different bee species in India, most of them solitary, but all important pollinators<sup>[viii]</sup>.



*The honey bees of India and percentages of scientific publications on the different honey bee species (photos of bees by Alberto Lucas López, graphics by Axel Brockmann).*



*Dwarf honey bee Apis florea and giant honey bee Apis dorsata on flowers of a bottlebrush tree  
(photo by Sebastian Walter).*

### **Fruitful relationships: The ecological and economic importance of wild honey bees**

*“Honeybees are only useful for honey, apart from that for nothing.”*

Many people in Bengaluru assume that the only benefit of honey bees is that they produce honey for human consumption. They are often not aware that bees pollinate many wild and cultivated plants; and thus are of high significance for the stability of terrestrial ecosystems – the survival of many plants, birds and other animals – as well as for human crop production and food security<sup>[ix]</sup>.

Unfortunately, there are not many comparative studies in India investigating the importance of different honeybee species or other bees for pollination. *Apis dorsata* has the biggest colonies, the largest foraging range and thus likely the biggest foraging force. However, a recent survey on pollinators visiting plants in Bangkok showed that the smaller dwarf honeybee visited almost four times, stingless bees even twelve times the number of flowers that were visited by *Apis dorsata*<sup>[x]</sup>. Yet, pollination interactions are more complex. A study on pollination success in Karnataka showed that under normal rainy conditions the fruit set is mainly dependent on stingless bees, whereas in drought years, with lower abundance of stingless bees, *Apis dorsata* foragers took over so that fruit set was similar in both years<sup>[xi]</sup>. For the pollination of unevenly and irregularly flowering trees of tropical forests, the migrating honey bees, especially *Apis dorsata*, are probably indispensable<sup>[xii]</sup>.





*In 2002, this banyan tree hosted about 100 *Apis dorsata* colonies. In 2017, when this photo was taken, only two colonies remained (photo by Sebastian Walter).*



*One of two *Apis dorsata* colonies in the banyan tree (photo by Sebastian Walter).*

## The abandoned Banyan tree: Decline of honey bees in rural areas

Huge losses in abundance and diversity of bees and other pollinating insects are observed in different regions of the world<sup>[xiii]</sup>. In this context, India received not much attention, even though the loss of wild pollinators might have grave consequences for one of the most populous and naturally diverse countries. Although there is not much reliable data on their abundances, there are already clear indications that wild bees are endangered in India, too – specifically the giant honey bees<sup>[xiv]</sup>.

Giant honey bees often nest in aggregations. The so-called ‘bee trees’ can host more than 50 colonies. A huge banyan, located amidst fields on the grounds of the University of Agricultural Sciences in Bengaluru, used to be such a bee tree. In 2002, about one hundred *Apis dorsata* colonies lived in this tree<sup>[xv]</sup>. *“They looked like big fruits. At sunset, first birds in the tree started flying – the colourful bee eaters. Then many thousands of bees from all the colonies started to fly and the tree released a humming sound that could be heard from far away. Really a magical spectacle of nature.”* Fifteen years later, only two colonies remained. Eucalyptus and other trees nearby, which provided a lot of nectar, were cut and the honey bees are gone.

Investigations in rural southern Karnataka showed a continuous decline of honey bee as well as stingless bee populations<sup>[xvi]</sup>. In particular, the giant honey bees experience an immense pressure due to human activities. Honey hunters often destroy the whole nest. Probably even more important is the loss of food resources and natural nesting sites, caused by deforestation, the cutting (down) of large trees on farmland, and the fast progressing urbanisation and landscape fragmentation<sup>[xvii]</sup>.

## Bengaluru – a city of refuge for bees?

Interestingly, the above-mentioned survey in southern Karnataka found most colonies of *Apis dorsata* and stingless bees not on farmland or in more natural habitats but in residential areas<sup>[xviii]</sup>. Cities are not necessarily bad for bees<sup>[xix]</sup>. Actually, several studies demonstrate that cities with gardens and green space provide a rich diversity of food plants and nesting sites. In view of the decline of insects in rural areas, it has been proposed that cities might function as refuges for pollinating insects, especially bees<sup>[xx]</sup>.

Zameeroddin and Vasuki Belavadi from the University of Agricultural Sciences in Bengaluru were looking for possible differences in bee diversity and numbers between urban and rural areas of northern Bengaluru<sup>[xxi]</sup>. They found virtually no difference: 46 versus 49 species in similar abundances. The results indicate that regarding bees the situation inside the city is neither better nor much worse than in



the agrarian landscape around Bengaluru, where the bees are confronted with a low diversity of plants, i.e. lack of flowers.

Other studies – mainly from Europe and North America – comparing highly urbanised areas to adjacent farmland found similar results, whereas more natural habitats usually show a clearly higher diversity<sup>[xxii]</sup>. For the United Kingdom, a clear correlation between the process of industrialising agriculture and the extinction of bees has been shown<sup>[xxiii]</sup>. Therefore, moderate urbanisation, with many diverse green spaces, can have a positive effect on pollinator diversity and abundance. High-level urbanisation, with a very dense structure of buildings and roads, usually has a negative impact on pollinators<sup>[xxiv]</sup>.

## **It's becoming unliveable: Transformation of a big city to a mega city**

Bengaluru is a fast-growing city. The official census in 2001 counted 5.1 million people, the latest one in 2011 counted 8.4 million. For 2020, the population was estimated to be about 14 million or nearly three times the population the city had 19 years ago<sup>[xxv]</sup>.

*“Obviously Bengaluru is growing very rapidly. Many people come to Bengaluru in search of jobs.”*

*“Also my village changes, it's already becoming a part of the city.”*

During the past decades, the former ‘Garden City’ Bengaluru has been transformed into the megacity Bengaluru. To get space for roads and buildings, many trees were cut down – the ‘green’ city became ‘grey’.

*“Bangalore...is a concrete jungle. ...And it's becoming unliveable.”*

Bengaluru is among the cities with highest air pollution globally. In 2012, Bengaluru's annual mean pollution level was about six times the maximum level recommended by the World Health Organisation. For humans, air pollution is a major health risk, causing for example heart and respiratory diseases<sup>[xxvi]</sup>. A recent study revealed that the same is true for giant honey bees in Bengaluru<sup>[xxvii]</sup>.



*On the way from the northern parts to the city centre of Bengaluru (photo by Sebastian Walter).*



*Nest of wild giant honey bees and remains of old combs at an office building in Indira Nagar in the centre of Bengaluru (photo by Sebastian Walter).*

## Natural balcony dwellers: Where the conflict begins

In Bengaluru, high-rise buildings have mushroomed due to the huge demand for commercial and residential spaces. Giant honey bees seem to be pre-adapted to this kind of cities. As *Apis dorsata* colonies like to nest high up in trees or at overhangs of rocks and cliffs, they are also attracted to human-made constructions like water towers and buildings with overhangs or balconies. Unconsciously, humans build artificial nest sites of giant honey bees.

*“You can see this in many other places also, honeybees nesting on the buildings... Because Bengaluru becomes more developed, more and more buildings coming up, trees are cut down. So, they occupy the buildings now.”*

That a loss of trees also meant a loss of natural nesting sites was probably a minor problem for the giant honey bees. This easy adaptation to a human-made environment can be regarded as a natural advantage for the bees. The bees can find new niches in the urbanised area by constructing nests at roofs and balconies, in front of offices and apartments. Unfortunately, this leads, inevitably, to human-honey bee conflict.

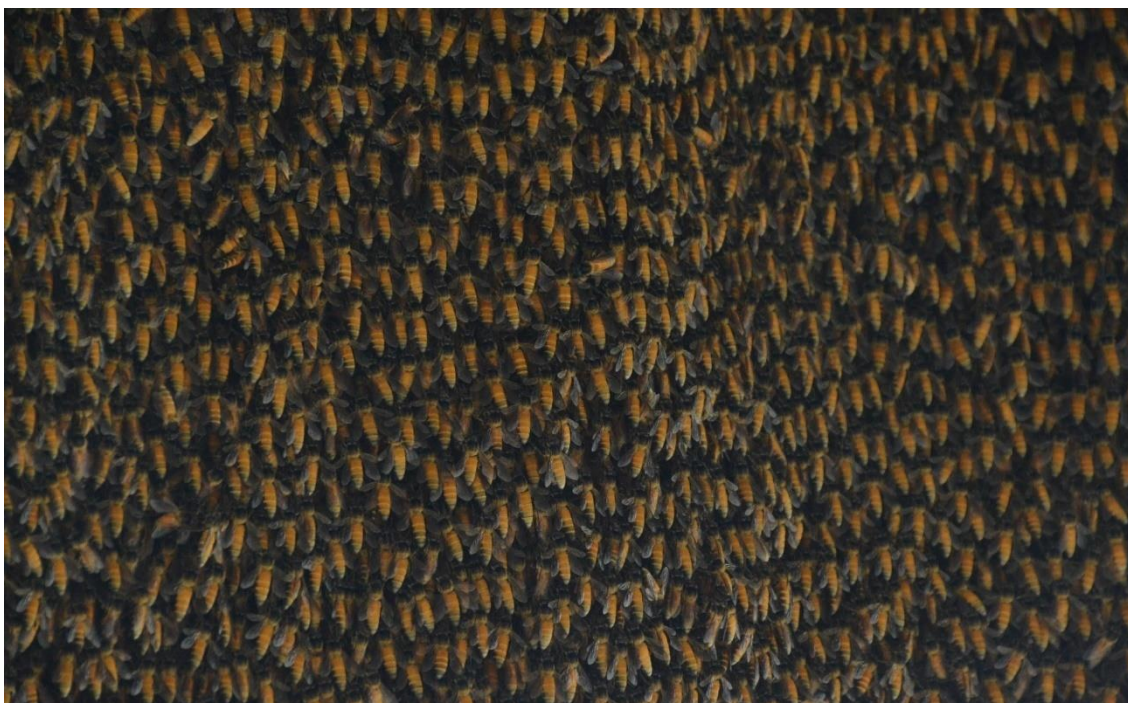


*Office on the 6<sup>th</sup> floor of the University of Agricultural Sciences with *Apis dorsata* nest in front of the opened windows (photo by Sebastian Walter).*





*Nest of Apis dorsata with flying bees, and view over the campus of the University of Agricultural Sciences in north Bengaluru (photo by Sebastian Walter).*



*'Bee curtain' of the Apis dorsata nest. A layer of worker bees clinging together covers the comb and protects brood and stored food against rain, wind, and predators (photo by Sebastian Walter).*



## Feared shift workers

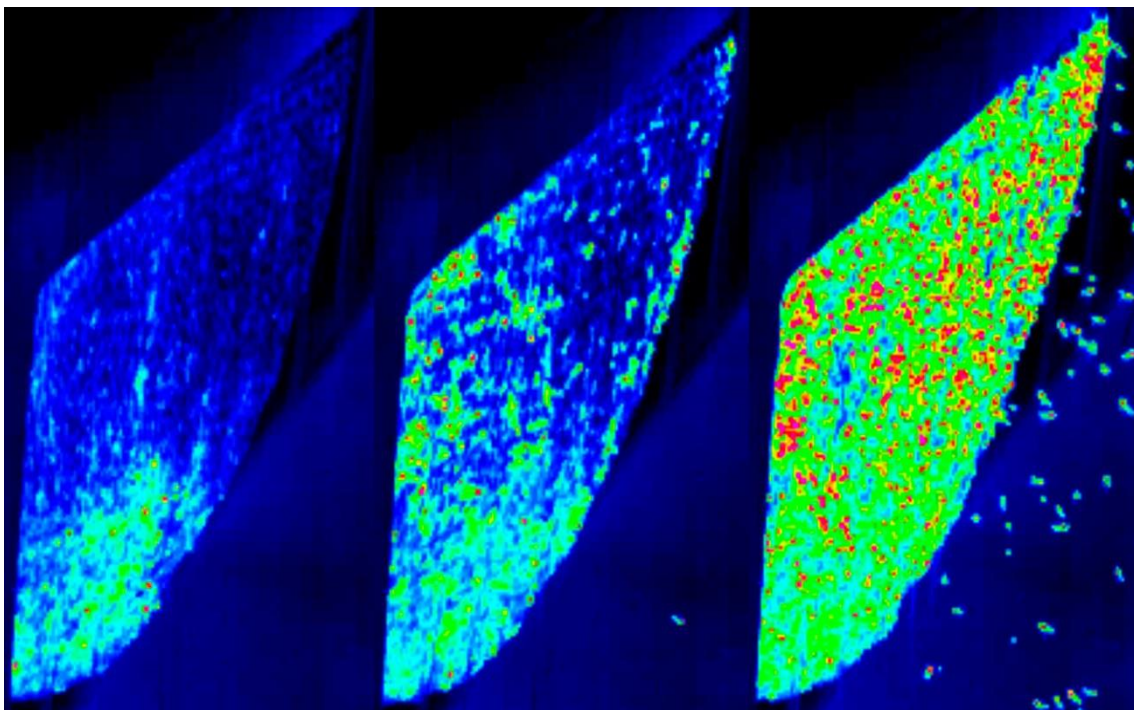
While humans go to sleep, *Apis dorsata* workers continue to forage. Different from all other honey bee species, giant honey bees are able to fly and forage at low light intensities<sup>[xxviii]</sup>. Therefore, they are not only active during the day, but also at night after sunset if the moon is shining or if there is ambient light from artificial sources. The bees get attracted to the light sources and enter human apartments through the open windows and fly around the lamps.

*“They...come into the rooms when the light is on.”*

Yet, not only at night, also during the day *Apis dorsata* behaves in frightening ways.

*“During early morning sometime there is a rearing, that means they all swarm around. Something happens for five, ten minutes. That time it’s a little scary. And in the evening, they are doing again the same.”*

This phenomenon called ‘mass flights’ appears often several times a day, most prominent at sunset. Scientists still discuss why *Apis dorsata* shows this behaviour. Possible explanations are, for example, reorganisation of the bee curtain, temperature regulation, flight exercises for young bees or ‘toilet’ flights<sup>[xxix]</sup>.



*Scientific observation of a mass-flight event. Body temperatures of bees are measured with a thermal camera during foraging activity (left), pre-mass-flight heating up (centre), and mass flight (right) (photos by Benjamin Rutschmann).*

## Beware of honey bees!

*“Especially in Bengaluru 100 per cent will be afraid of bees.”*

*Apis dorsata* bees are big as wasps or hornets. Most people are afraid of them. The bees behave in strange ways, react very sensitive to disturbances and are considered to be rather aggressive, because when agitated they start a mass attack<sup>[xxx]</sup>.

*“Definitely it is a problem when the bees are disturbed. ...I think it has happened two or three times in our university. During student strikes, when there are drums and everything. ...So many people were injured [by bees] on that day.”*

Although usually at least 150 to 1,000 honey-bee stings are necessary to kill somebody who is not allergic to the bee venom<sup>[xxxi]</sup> mass attacks can be very dangerous. Big honey bee colonies have tens of thousands of workers and if one *Apis dorsata* colony starts a mass attack, the neighbouring colonies will join in.

*“I have been attacked by bees once, when I was on a picnic. Then everybody says that you have to sleep down, so that the bees don’t attack your face, and you have to curl up. I think in panic you just run, and you don’t know what to do.”*



Warning board at the entrance to Bengaluru’s botanical garden (photo by Sebastian Walter).

## Green spaces become no-go areas for bees

Urban green spaces are important refuges for wild bees, but they are also important for the recreation and health of urban citizens<sup>[xxxii]</sup>. Bengaluru's largest green space is Lalbagh, the botanical garden.

*"Once upon a time Bangalore was called a garden city. So this is the last kind of what remains. ... This whole space is air-conditioned with so many trees."*

Warning boards at the entrance gates give instructions how people should behave to prevent bee attacks. The boards, along with first-aid stations and a rescue tent, were installed after two incidents of mass attacks by giant honey bees during the annual flower shows in Lalbagh. In 2016, two young adults had to be treated in the hospital; in 2015, a seven-year-old girl playing close to a tree with *Apis dorsata* colonies even died<sup>[xxxiii]</sup>. Probably the bees were agitated by the unusual masses of people 'flooding' the park on these days.

*"It was something like a shock to us."*

Probably as another reaction to the bee attacks, in 2017, nearly all *Apis dorsata* nests were removed from the trees in Lalbagh, which had been home to a large number of colonies<sup>[xxxiv]</sup>.

*"It was a constant thing for many people to come here and look at all the honeycombs. It looked very beautiful.... And now we see that the honey bees are removed, for human safety."*

## How to get rid of them: Pesticides against bee colonies

*"I don't like bees, they're a pest!" "In the forest it's beautiful, in the city it's a nuisance."*

People see the bees as enemies or at least as a nuisance, like those insects that enter your homes, for example, cockroaches. Thus, giant honey bees are treated like a pest insect in Bengaluru and other parts of India. It is allowed to call a pest management company to remove a honey bee colony nesting under the roof of your house or on your balcony.

*"The housekeeping service...persuaded me to try to get rid of that. ...people were complaining that bees try to enter their home." "The first thing if people see bees is they panic. ...So they call pest control companies. They come, spray pesticide. In the morning a bed of dead bees will be there."*

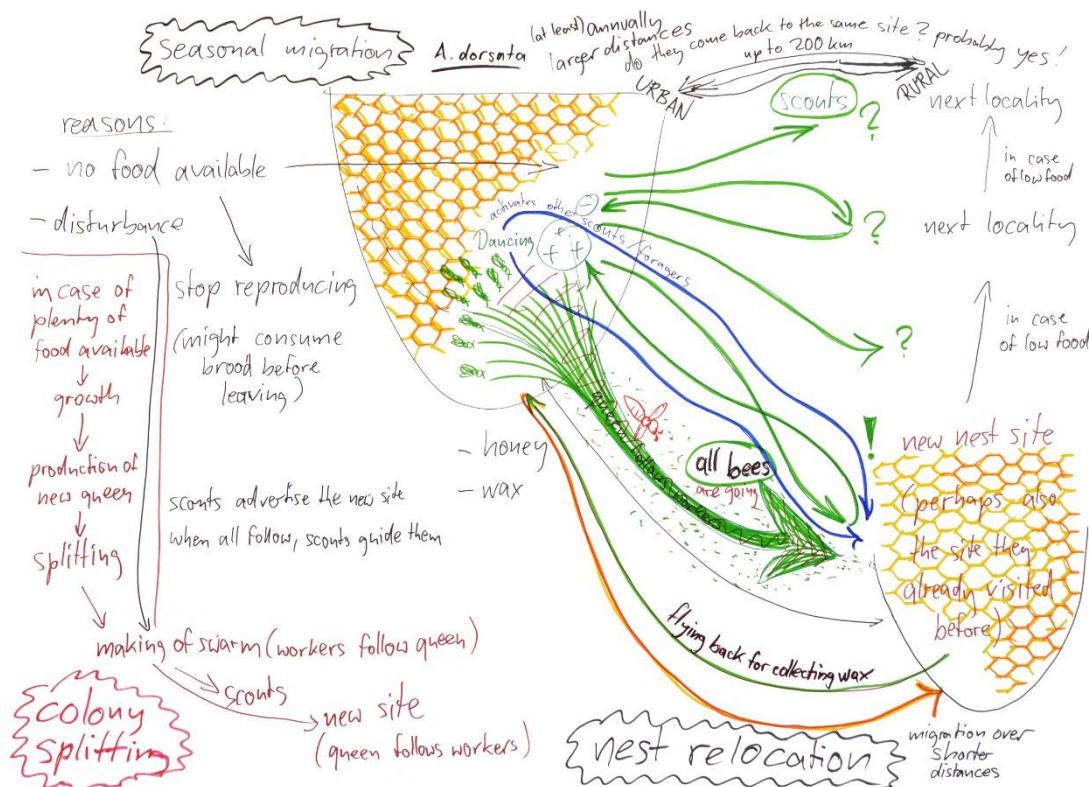
Investigations in rural and urban areas of Bengaluru in 2013 and 2014 showed that especially in urban areas a large number of bee colonies were destroyed with insecticides. "These brutal killings are responsible for the death of thousands of *Apis dorsata* colonies every year"<sup>[xxxv]</sup>.



And the problem will persist. Removing a colony is only a short-term solution. *Apis dorsata* colonies are picky in which places they use as nesting sites, so the balcony chosen by one colony will be chosen by other colonies in the future.

## The decline of *Apis dorsata* in Bengaluru

A survey of *Apis dorsata* colonies in parts of Bengaluru showed that between 1987 and 2014 the number of colonies was reduced by 90 per cent<sup>[xxxvi]</sup>. The observed strong decline of *Apis dorsata* populations has probably many reasons: Firstly, the felling of trees in the context of city development reduced important food sources of the bees; secondly, the increasing air pollution; and thirdly, the intentional killing of colonies nesting at buildings by means of chemicals.



Drawing with schematic representation of different forms of migration, created by Sebastian Walter and NCBS students during a seminar at the National Centre for Biological Sciences.

## Seasonal workers: Migration connects urban and rural regions

Once a year Bengaluru's *Apis dorsata* colonies leave their nests voluntarily.

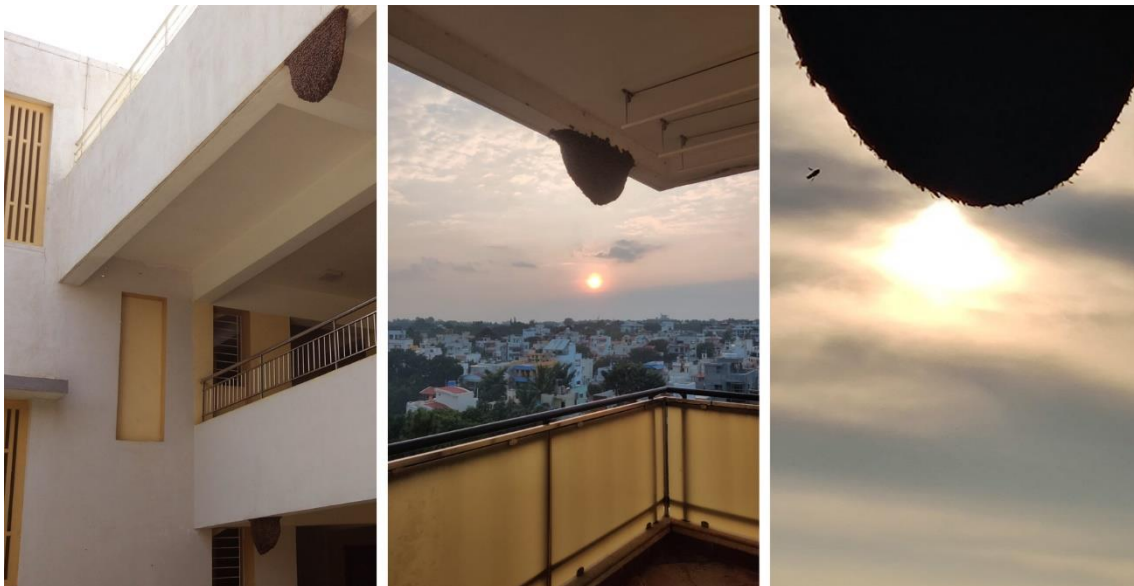


*“Most of the time during the year they are present here. During one particular time they just fly away, and then come back and build another nest in the same place.”*

Like humans, who move to places like Bengaluru because they find better living conditions there, giant honey bees also migrate. The colonies perform seasonal migrations over large distances (up to at least 200 km) like bird or butterfly migrations. These have evolved as adaptations to recurrent annual unfavourable weather conditions like temperature declines during winter or sustained rains during monsoon, which affect food availability and survival rate.

In Bengaluru, monsoon lasts from July to September. Not many plants flower during these months, and the colonies depart. Later, with changing conditions, they return to the original location<sup>[xxxvii]</sup>.

As a consequence of this behaviour – wandering constantly between different places – extinction of colonies in the city directly causes a loss of honeybees that are available for pollination outside the city, on farmland and in forests.



*Colonies of Apis dorsata on balconies (photos by Axel Brockmann and Vatsala Thirumalai).*

## **They do have a right to survive: Coexistence is possible**

*“Now one person got attacked in many, many years. A young kid died...but it does not mean that beehives should be removed, but [there should be] more awareness [about] how you could live with them.”*

In all parts of Bengaluru remains of removed *Apis dorsata* nests can be observed. You will, however, also find intact colonies and people who think that treatment with pesticides is the wrong way to deal

with giant honey bees in the city. In interviews with people who work or live with colonies of the giant honey bee in front of their office or apartment we also found awareness of their importance and respect for them as living beings.

*“I think bees are an important part of our ecosystem.” “They are fighting for their survival, like everyone of us they do have a right to survive.”*

These people developed different strategies to live more or less constantly with bees’ nests in their surroundings. The easiest way is to not open the windows. However, even with open windows giant honey bees seem to be no problem as long as there is no artificial light in the room, people do not smoke or burn incense sticks and there is no extraordinary disturbance.

*“The bees are not a problem for us. ...We never open the windows.” “Now the windows are open, without a disturbance they will not harm any people.”*

With simple protective measures a more or less normal life is possible:

*“Initially it was a problem...Then we put a net on the balcony, so that they don’t come in. And slowly I’ve the feeling that they got used to the light. And they don’t bother us anymore.”*

If they have time to adapt, giant honey bees can get used to initially strongly disturbing situations<sup>[xxxviii]</sup>. In cases where *Apis dorsata* colonies must be removed, smoking the colony and only removing the comb – which will make the bees to move away – is much bee-friendlier than to kill them all with pesticides. Even the transfer of a colony together with its nest is possible. However, due to the phenomenon that *Apis dorsata* colonies have preferred nesting sites, residents that had removed colonies from their balconies should take measures to prevent new colonies from building nests on their balconies.



*A worker of the giant honey bee (photo by Sebastian Walter).*

## Time to take action

*“I think the conflict between the bees and the human beings is a sign of a critical junction in our city’s life. When people are really fighting the bees, it means they’re also fighting nature. This is also symbolic about the situation how we are treating nature around us, and we want to occupy spaces. That does not allow for this kind of diversity of plants or insects and animals to survive. We’re pushing them to the edge of the city, we don’t want to have any connection with it.”*

Within the next decade, India is expected to become the world’s most populous country<sup>[xxxix]</sup> and to experience the world’s second largest growth of urban areas. This growth will mainly take place on former farmland<sup>[xl]</sup>. Environmental degradation already causes major economic, social, and health problems<sup>[xli]</sup>. India’s hunger situation is still serious<sup>[xlii]</sup>. A further decline of vitally important wild pollinators like the giant honey bees must be prevented. Certainly, it is time to act.

The Indian government focuses its attention on promoting and studying beekeeping with *Apis cerana* and the introduced *Apis mellifera*. A few years ago, the “Sweet Revolution” was launched to expand beekeeping and honey production in rural areas to increase the income of farmers. Indians do not consume or use much honey in their daily life and most of the honey produced in India is exported to the West, which is highly profitable. There is not much public or political interest in the other Indian honey bee species. This needs to be changed, because many plants depend on these wild honey bee species for pollination. Studying their biology and ecology as well as continuous monitoring studies on their populations are necessary for their conservation<sup>[xliii]</sup>. In the process of urban transformation we must consider plants and animals and should actively design pollinator habitats<sup>[xliv]</sup>.

There is a public responsibility and initiative needed to maintain these animals. It is important to create more public awareness of the value of wild pollinators like *Apis dorsata*, and of their difficult situation. People must know nature to protect it. Apparently, insufficient knowledge and fear are the main reasons for destroying colonies of the giant honeybee, one of India’s prime pollinators. We should provide people with better knowledge about wild honey bees and teach them how to interact with them in non-harmful ways.

We are part of a complicated, fragile network of interacting organisms. The history of biological evolution teaches us that protecting diversity is to our own advantage<sup>[xlv]</sup>.

In the urban age, cities must be a place to be for bees, even if they are not always ‘sweet’.

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## Endnotes

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[<sup>i</sup>] The Nature Conservancy 2018: Nature in the Urban Century.

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