THE TRANSPARENT BEEHIVE NOTEBOOK

ANNEMARIE MAES

the Transparent Beehive Cabinet
Objects and Experiments

Texts and photographs by AnneMarie Maes
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Creating Ecological Corridors in Cities

AnneMarie Maes is representative of a new wave of artists for which art is life and life is ecological.

This direction of work is of course not entirely new. It is the visionary 20th century artist Joseph Beuys who already in the nineteen sixties showed the need for a radically different kind of art. He argued forcefully against the wasteful use of natural resources and in favor of a social humanitarianism that tries to connect individuals back to their communities and to the ecosystems on which human life depends. Beuys lived this vision and translated it into a broad range of multi-media art works, performances, lectures, and community activism that still resonates today. Indeed, over the past decades, our society has veered even more strongly towards individualistic tendencies, partly under the influence of technologies that isolate us from the rest of the world. And the rest of the living world that used to dominate the planet and is crucial for our survival is even more under threat by massive industrialisation, sprawling cities, and the technological control of agriculture. In this context, it is questionable whether we need the kind of individualistic art currently celebrated by the art market. The revolutionary stance advocated by Beuys and practised by artists such as AnneMarie Maes is more than ever relevant.

AnneMarie Maes is totally absorbed with issues of sustainability in the way she lives and the way she works as an artist (http://annemariemaes.net). Her engagement translates into the creation of urban gardens, the organisation of communities, protest against genetically modified foods and the lack of open green spaces in cities, the preservation and exchange of seeds for agriculture, and, above all, projects to understand and do something about the causes of the honey bee colony collapses that are now rampant in all highly industrialised areas of the world. Many of these activities take place through collectives of artists and scientists in Brussels, in particular okno (http://okno.be) and So-oN (http://so-on.be). These collectives organise workshops that use Do-It-Yourself technologies to explore new ways to communicate, observe, and share observations of nature in the city. They push for societal changes through grassroots activism and interventions. These activities blur the distinction between art and life and show their impact almost exclusively outside the narrow context of traditional art venues.

AnneMarie Maes structures her work through long term projects that generate a steady stream of interventions, experiments, community activities, and art works. One example is the Open Greens Project (2008-2013) that focused on setting up and maintaining urban gardens on rooftops in central Brussels. Creating an urban garden is a huge undertaking that requires solving a large range of practical problems: convincing owners of parking lots, getting soil up on the roof, building a green house, dealing with a steady supply of rainwater, selecting and planting seeds, dealing with birds and rodents, combatting weeds, harvesting and preserving produce from the garden, etc. Maes her art work flows naturally from the daily practice of dealing with these gardens and she has enhanced them with sensors and sensor networks to make the invisible visible and allow continuous monitoring through the web. The many visitors who have come to see this garden are entirely amazed and enchanted. They are not even aware that they see the result of an artistic practice.

Another example is the Politics of Change project (2007-2009), which is one of several projects driven by grassroots activism, eco-technology and networks of women to build integrated and sustainable relationships between people, their environment and technology. It involved an educational initiative called Barefoot College, located in Tilonia, Rajasthan (India) training solar engineers. The learning environment is open and decentralized. Knowledge is passed on in the collective from the bottom up using a hands-on approach. The village community selects which women will be sent on a 6 months solar engineer training, and every village family contributes a share in the remuneration of the engineers to set up and maintain the village solar system. Maes extensively visited the Barefoot College initiative, co-organised workshops there, and brought back information with workshops and programs of free discussion and dialogue, documented in multimedia archive-installations.

Another example project, that has provided the source material

for the present book, is the Transparent Beehive Project (2010-2013). This project started as a natural continuation of urban gardening, because without bee polination it is not possible to cultivate a large majority of the fruits and plants on which we live. Engaging seriously with bees in cities has become urgent because the honeybee species is under threat in rural areas due to monoculture, urbanisation, pesticides, air polution, and several other factors. The project focused on building an observation hive with which it was possible to see, hear, and track the development of a bee colony.
The beehive starts from an original transparent design based on the "leaf beehive" originally built by the blind Swiss naturalist François Huber at the end of the 18th century. The bees enter and leave the hive through a glass pipe opened to the outside world. The hive has been enhanced with cameras, contact microphones, and other sensors. AnneMarie Maes, who is an accomplished beekeeper and herborist, was able to initialise the hive with young bees and a queen. From then on the bees took over, building the characteristic comb structure, collecting honey, pollen, and wax, and maintaining the life of the colony, including the regulation of temperature. Sadly, the hive was also attacked by waxmoth and dramatically collapsed into a useless ugly mess after performing well for a complete season. The fascinating development from birth to death has been seen by the many visitors who came to see the installation at okno. They were often stunned when experiencing, often for the first time in their life, the remarkable activities of bees and bee colonies in such close contact.

Honey, wax and bees are the essential ingredients of Maes her art works, and it is no accident that this was also the case in the work of Joseph Beuys. The way a bee colony works is a symbol for the way a society can operate and bees have an intimate relation to the local environment because they go out foraging for food and thus allow observers to map out the ecological resources and the state of the environment around the hive. The bee colony creates remarkable hexagonal structures through collective action and a bee is an absolute wonder of natural engineering. Maes is in her heart a naturalist, in the 17th century tradition of natural history. She is carefully observing nature using her artistic eye to highlight the remarkable forms and structures found there and performing experiments - mostly without complex scientific equipment - that bring out the beauty and sophistication of the natural world.

The present book documents some of the objects and situations that came out of the Transparent Beehive Project. They form a cabinet of curiosities, as you would find in a 'Wunderkammer' of the early 18th century naturalists or in today's natural history musea. We see the tools used by beekeepers to classify pollen based on color or an ingenious compas to map out where bees go foraging. We find pollen brought back by the bees to the hive and plant specimen that are the source of these pollen. There are fragments of the combs created by the bees, and fascinating close-up pictures of their skin and body parts, including remarkable images produced with a scanning electron microscope and using X-rays. All these objects are extraordinary and testify to the ingenuity of nature.

Other objects and drawings zoom in on the remarkable geometric structures created by Nature: the wings of a dragon fly, which has the geometrical structure of a Voronoi diagram, the sexagonal pattern of honeycombs, the seed structure of sunflowers, which can be described using a Fibonacci series, the remarkable spheres of pollen with regular pointed structures. Maes has also been working with wax as a basic material that envelopes objects and thus shows them in an entirely new light. She drips found objects in the wax extracted and purified from the Transparent Beehive.

The book also shows objects and documents resulting from experiments and observations, occasionally in interaction with scientists. For example, genetic material (RNA samples) has been taken from living material on the bodies of the bees and sequenced to detect which viruses and bacteria were attacking them. There are the results of an analysis of the honey produced in the Transparent Beehive, made by a professional laboratory and showing that honey from the hive was less poluted and of higher quality than some of the honey collected in rural areas. Another amazing item is a design and a prototype of a battery based on honey and lemon juice. The cabinet contains a host of other objects: data sources, the schema for the sensors, graphs resulting from monitoring the hive, images taken from video streams recorded with cameras inside the hive.

All of this inspires wonder about the remarkable world of bees and admiration for the artistic engagement that AnneMarie Maes has developed over the years, particularly because this cabinet is showing just a tip of the iceberg of the many activities she has carried out around bees and beehives. Moreover the Transparent Beehive is just one aspect of her broader goal of trying to create Ecological Corridors in urban environments, a project she launched at Documenta 13 in Kassel in a salon organized by the Critical Art Ensemble.

Ecological Corridors is a new medium of social sculpture, a Gesamtkunstwerk that relies on the creative participation of many. Corridors are ephemeral living structures in the form of green spaces connected through animal life (in particular bee colonies). They are set up and maintained by urban communities to regenerate areas of the city, particularly areas which are subject to social and urban stress. Maes sees Corridors as art works that contribute to social cohesion and sustainability by raising awareness and minimizing resource waste. Artists create the safe spaces that enable the disruptive activities required to make corridors and they make the internal structure and activities of corridors visible through visual and auditory representations.

Luc Steels, Barcelona October 9, 2013

1. the Hive

Fig.1
The Transparent Beehive was installed april 2012 in the Drying Room, my laboratory in the rooftop garden of the artist collective okno in Brussels. The purpose was to study the development of the bee colony and to create a slowly evolving living sculpture.

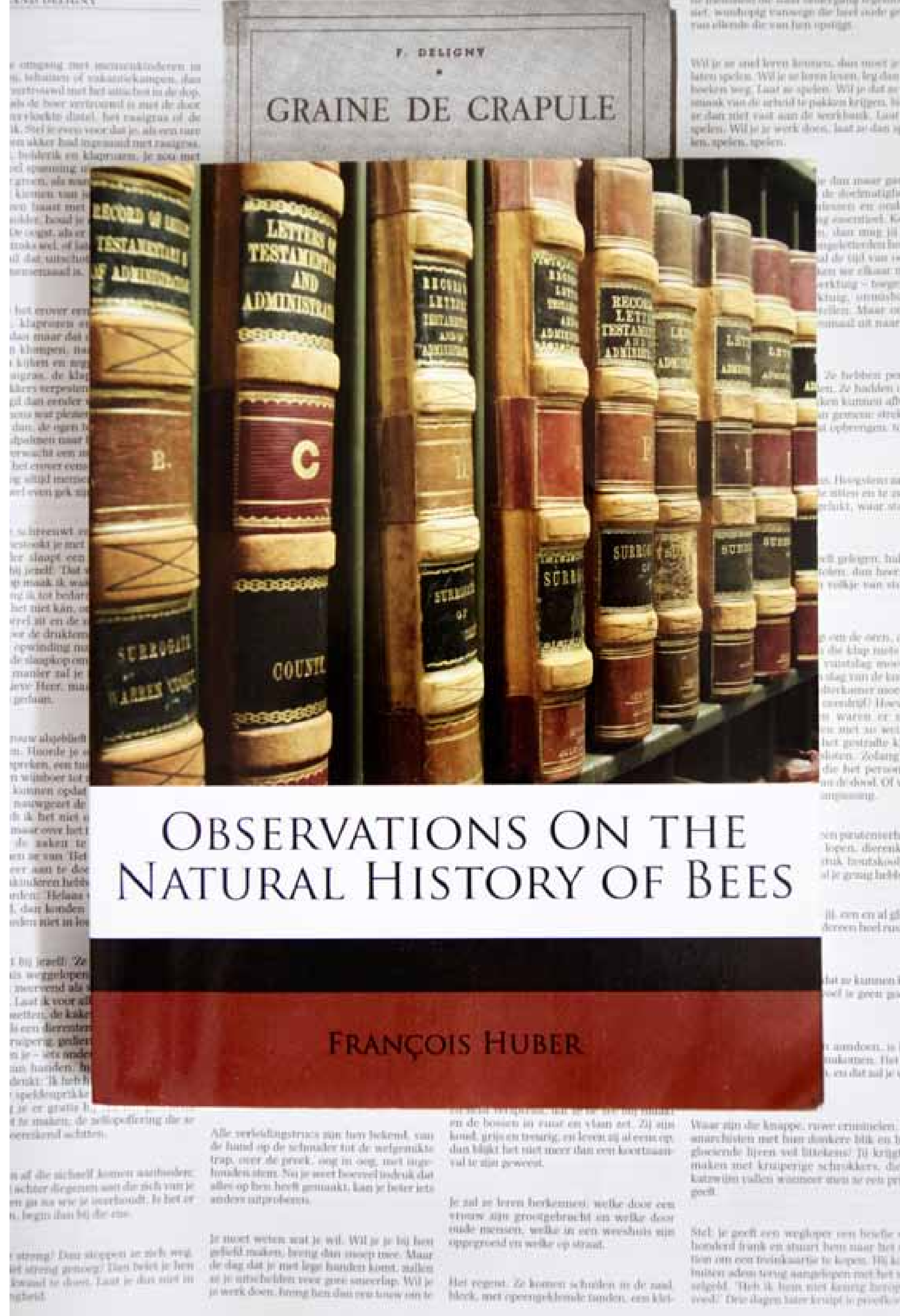

Fig.2
The work of François Huber, a blind entomologist working around 1800, was my source of inspiration.
He has created several observation beehives.
One of his hives [called the leaf hive] has the frames positioned as the pages of a book and held together by hinges.

Fig.3
I decided to remodel the leaf beehive and to integrate also monitoring technology.
The Transparent Beehive is made from plexiglass, wood, metal and aluminium.
Twelve vertical frames are mounted on dry-running linear guides.
You can easily slide them apart to inspect the colony.
The plexiglass box can be opened from three sides and the fourth side is perforated for aeration.

Fig.4 - The plexiglass cover has holes for the audio cables which connect the pre-amplifiers on top of each frame with the amplifier that is mounted beneath the wooden basis of the hive. Each pre-amp has a little red led light to verify the correct transmission of the audio signal.

We also see the beginning of the tube through which the bees leave the hive.

Fig.5
The twelve wooden frames are covered with an aluminium border and are set in a vertical position.
Twelve piezo contact microphones are installed in the frames.
Eight of them are fixed with fine wires to small springs, four smaller ones are attached between the wood and the outside aluminium border.
The contact microphones are very sensitive.
They pick up the most subtle touch and are designed to sense audio vibrations through solid objects.

Fig.6
April 24th. I introduced a colony of Apis mellifera carnica.
I collected several cups of young bees from four other beehives on another rooftop garden.
I transported them in a cardboard box to the Drying Room where the Transparent Beehive was ready and waiting to welcome them.

Fig.7 - To help the new colony building up their nest I gave them some food. Making wax and building honey comb is an energy consuming activity. As a starter I put some sections of comb with sealed honey cells from another hive, and I added two plastic jars: one with water and one with liquid honey.
In the jars float small pieces of sponge for the bees to sit on while drinking.

Fig.8
April 25th. I bought a young carnica queen from a queen breeder. The queen was born late summer 2011, she is marked with a white dot.

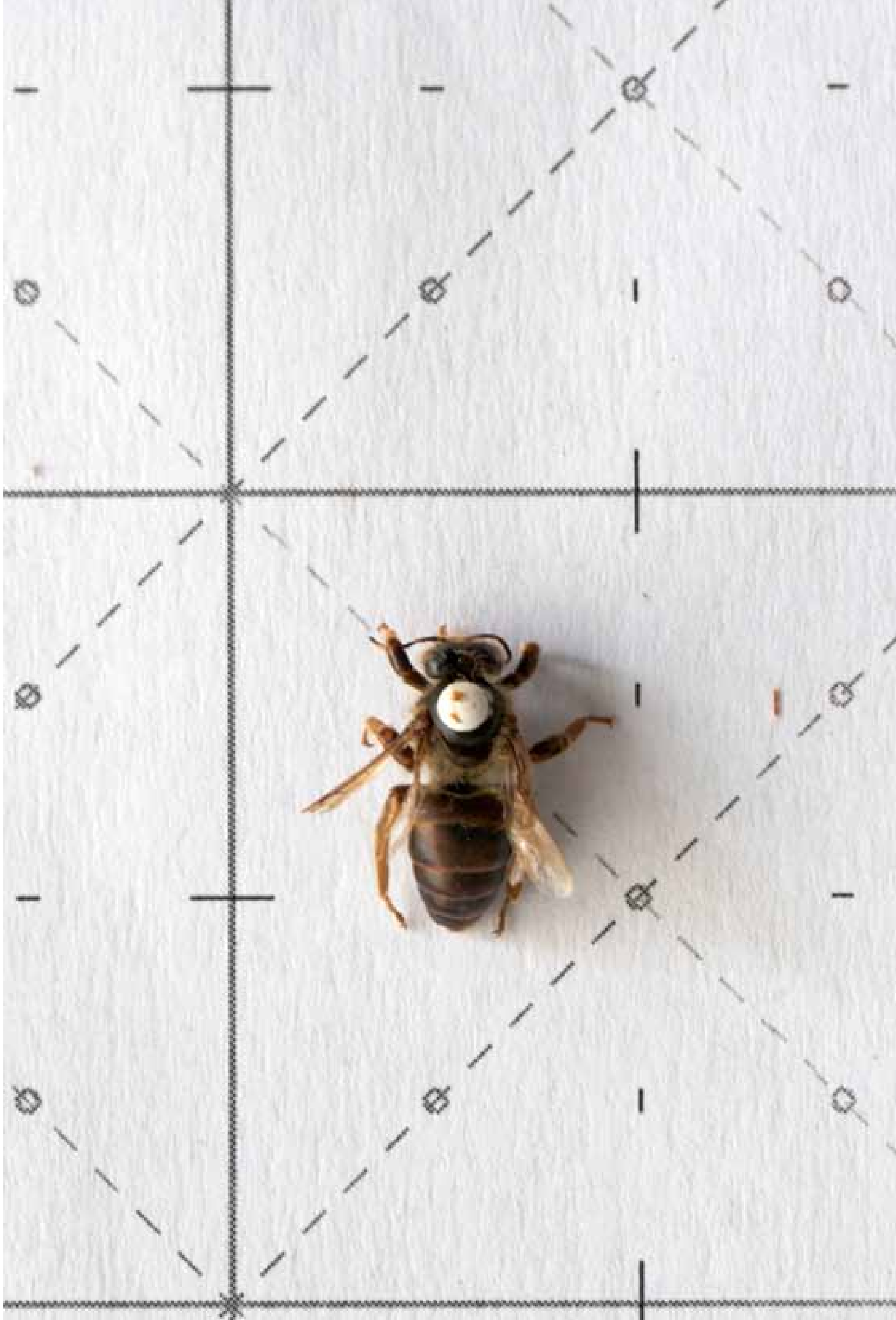

Fig.9
Introduction of the new queen in the hive.
She arrives with her court of young worker bees.
The hole on the bottom of the yellow box is sealed with sugar paste and newspaper.
The worker bees from the colony will gnaw away the paste to free the queen from the box and accept her as the mother of the colony.

Fig.10
The hive is connected to the outside world with a plexiglass tube, linking the top of the hive with the upper window. Unfortunately the only possible position for the tube is in an angle of 90 degrees. This makes it for the forager bees a bit more difficult to leave or enter the hive, but in itself it should not be an obstacle for the bees to move freely around.

Fig.11
April 26th. I discover that the bees murdered the queen!
Drama in the hive! The new queen, marked white,
was suffocated by the worker bees.
What happened? Why did the worker bees not accept this queen?
A colony without a queen is doomed to die.
I try to help the queenless colony by introducing a frame with
day-fresh eggs from another hive.
If the colony is really without queen, they will execute
an emergency supersedure and raise as soon as possible
a new queen.

Fig.12
But the real story is something completely different.
By collecting young bees from my other hives
for populating the Transparent Hive,
I took -by accident- also the queen from one of the rooftop hives.
I did not notice that there was already a queen introduced in the
Transparent Beehive together with the new young bees!
There can be only one queen in the colony, so when I introduced
the white one they had a fight that same night
and the newcomer had to pay for it with her life.

Fig.13
Bees are attracted by sunlight.
Once I 've put them in the hive, they all collect on the side facing the outside room-window.
They want to fly out but they cannot leave the hive, as they don't notice the hole in the top.
I make a cover in felt to obscure the hive and to temper the sunlight.
I leave an opening around the exit hole and thus the tube is nicely lit by the sun.

Fig.14 - Finally, the first bee finds her way out and proudly she returns to communicate to her sisters how to reach the foraging fields. Immediately the traffic starts. Going up and taking the corner does not seem difficult. The only problematic situation is when they have to eliminate the dead bees. Going up with two causes troubles. I will have to adjust the tube.

The open grid

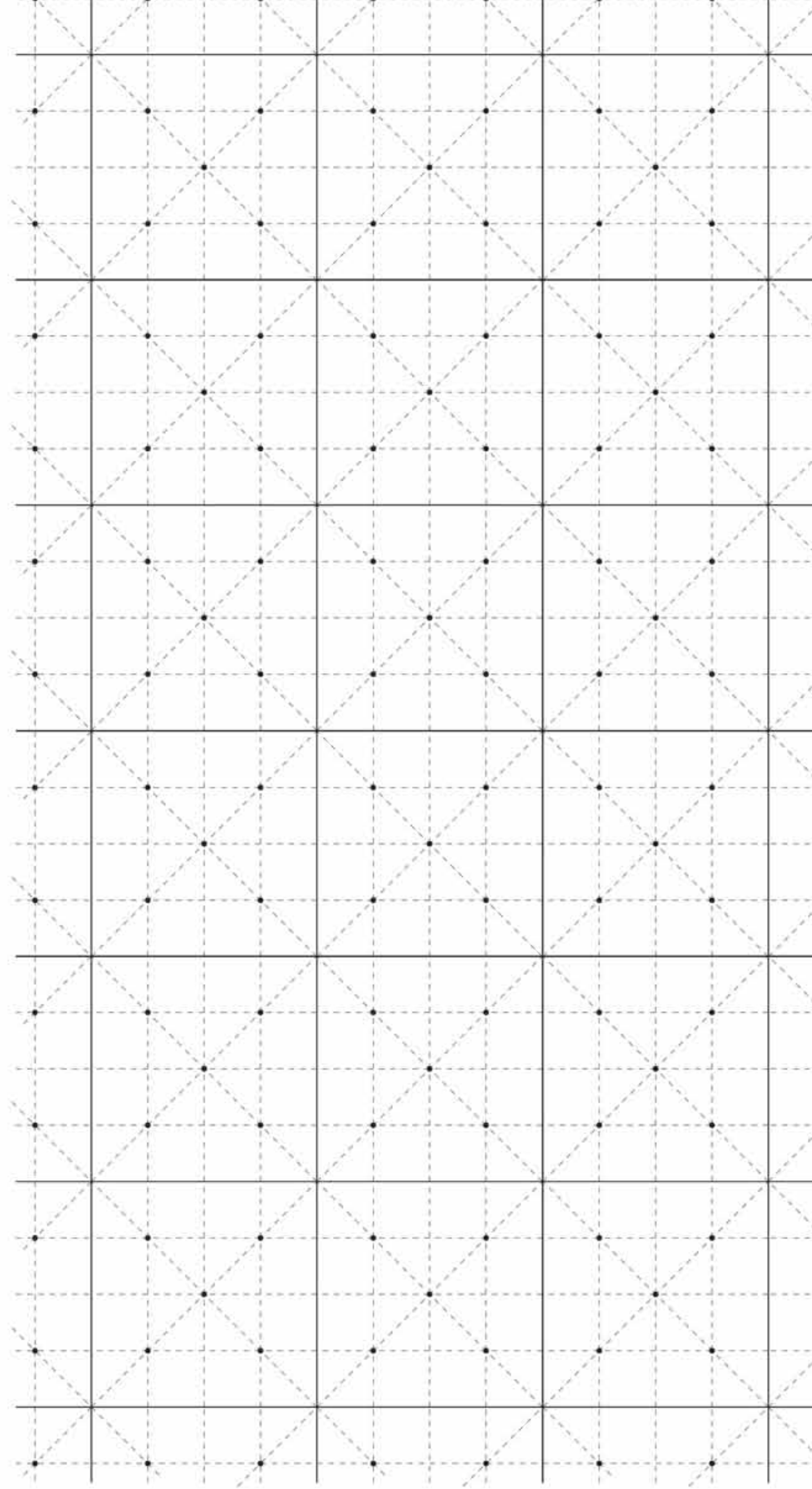

Fig.15
The Transparent Beehive is built along the principles of the OpenStructures project.
The OS project explores the possibility of a modular construction model where everyone designs for everyone on the basis of one shared geometrical grid.
It initiates a kind of collaborative Meccano to which everybody can contribute parts, components and structures.

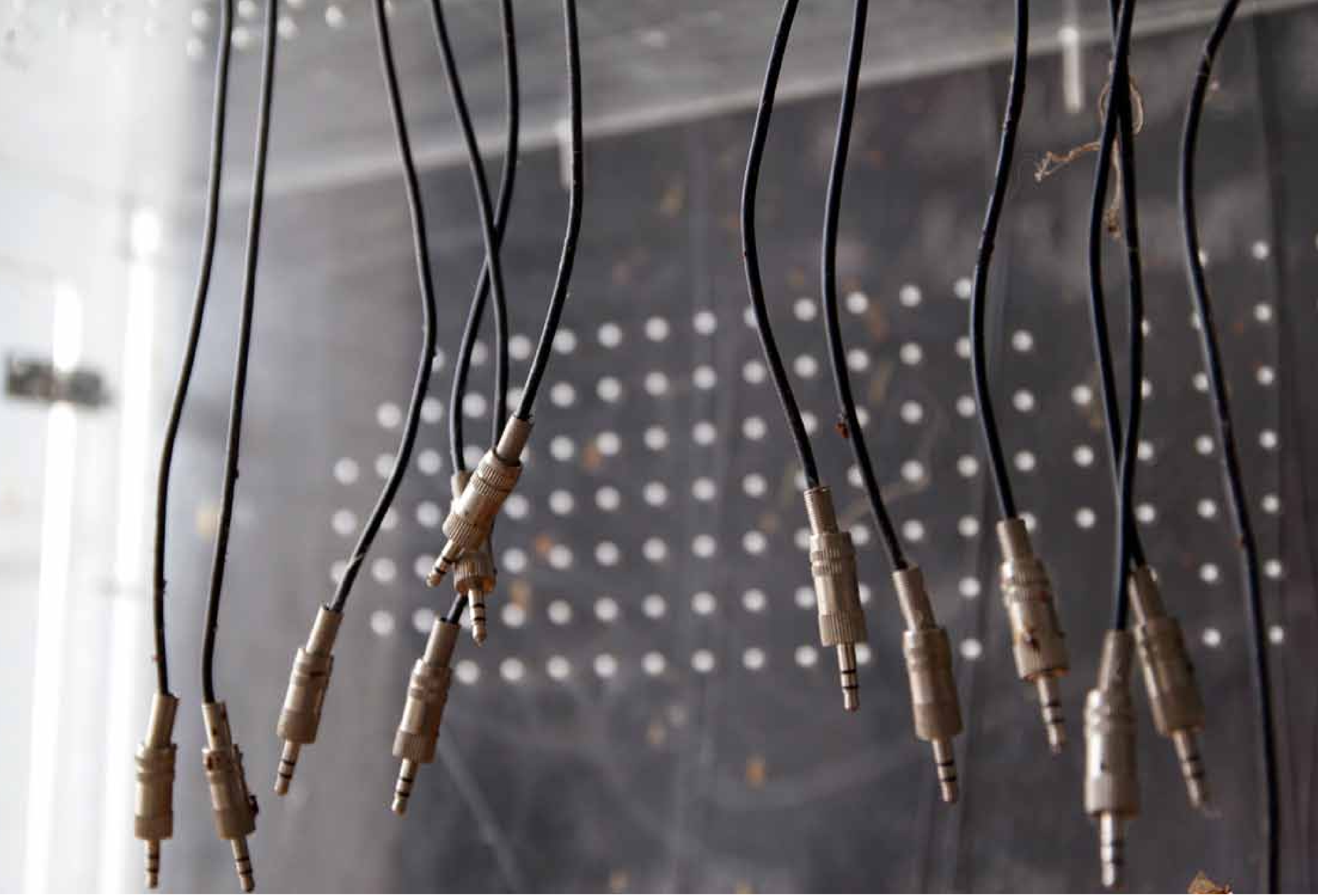

Fig.16 - The audiocables pass through custom made little holes in the top cover of the beehive. They connect the pre-amps on top of the frames, which are picking up the subtle sounds of the bees running over the contact microphones, to the amplifier which is fixed under the wooden plank of the hive.
The plexi beehive acts as a resonance box which alters sounds from the moment that the volume inside changes. When the bees build their comb around the transducers, they create variations in sound.

Fig.17 - Also, the growth of the colony gives difference in mass. The two big speakers make the changes in the colony behaviour audible. This is very slow art, where every moment of perception gives a different reading.

Fig.18 - Social insects are a crucial element in our ecosystem. The study and monitoring of the honeybees allows for experimentation with couplings between nature and technology. I like the metaphor of 'reading the development of a colony by browsing through a book'. I want to set up a real collaboration with the bees. I introduce them to the public as performers.

Fig.19
April 30th. I start organising a series of workshops at the artist collective okno to set up monitoring systems for understanding the distributed intelligence of honeybee colonies : their behaviour, ecology and sociobiology.
By monitoring the bees and beehives with all kinds of sensors, we examine the colony as a community, and its relation to the urban environment.
I document this research with all kind of media and I use the extracted data to make artworks based upon the bees' behaviour over time.
My goal is to establish a new connection between nature and technology.

2. bee monitoring

Fig.20
The observation- and sensor enhanced beehive offers an ideal setup to monitor the honeybee colony and its environment. Numerous possibilities for observing the bees' behaviour and measurements of internal properties of the hive [such as temperature and humidity] are provided as well as external measurements about climate, soil and vegetation. Storing the data over a 12 months period allows not only a very detailed observation but also the ability to discover and follow long-term trends of complex relations between the colony and its environment.

Fig.21- The observation hive has windows on four sides and is equipped with different sensors, webcams and contact microphones that allow a close reading of the bees' behaviour inside the hive. Via the webcams and through the windows the bees can be observed.

Fig.22
The webcam is stripped from its case and modified to suit filming in a small space. It is equipped with infrared leds to make recordings in the semi-darkness of the beehive. The bees are not disturbed by this red light. Their vision spectrum ranges from ultra violet (what a human eye cannot perceive) and it stops before red range - bees cannot see red. The camera monitors the movement of bees over the frames in the hive and the passage through the tube is recorded at 15frames per second. The webcams are connected to a PC board that is configured as a streaming server. It makes the images of the hive in real time available on the internet.

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INCOMING DATA

Fig.23 - The monitoring of the bees began from the early building up of their nest. Temperature, humidity and CO2 data in the hive are logged and linked with a timestamp to the video images, and these data can also be compared to similar data collected outside of the hive.

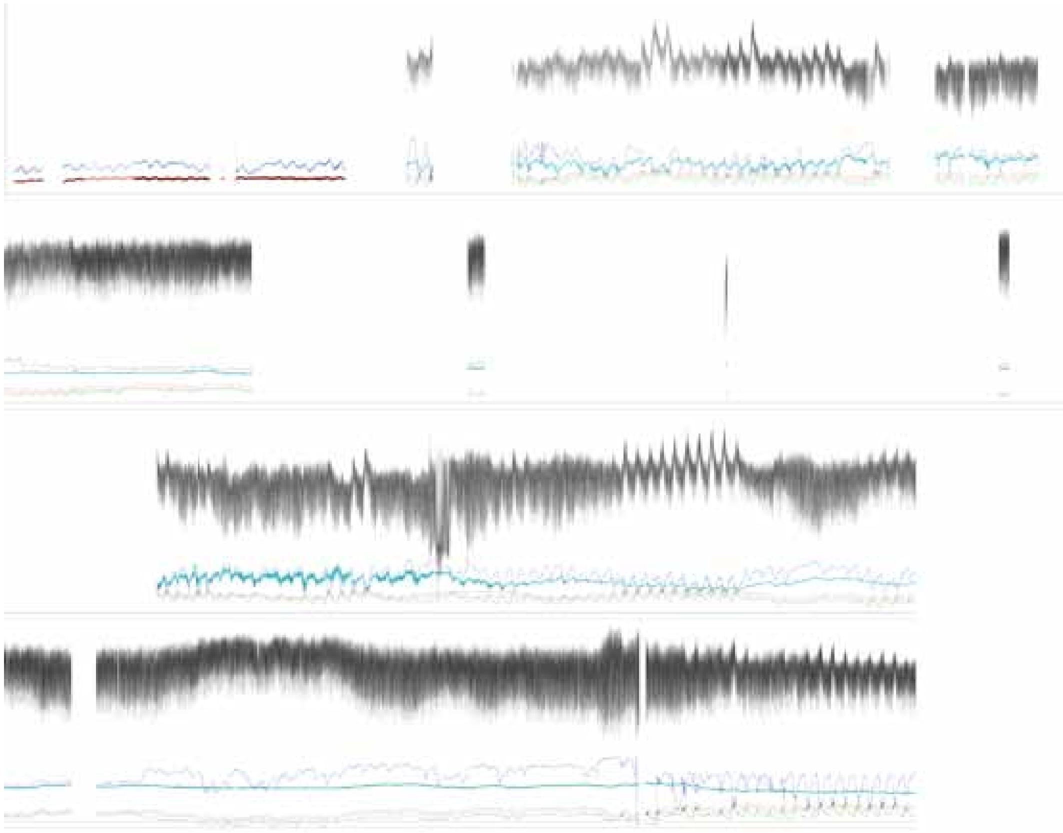


Fig.24
Two temperature sensors and a humidity sensor are installed in the hive. There is also a combined temperature/humidity sensor placed outside in the rooftop garden to measure the environmental information.
The monitoring system is logging all these data.
The sensors are connected to an arduino board, which is linked to the internet.
With this set up I can follow at any time the warming up and cooling down in the hive.
Temperature and humidity inside and outside the hive are important indicators of hive health.
The graph at the right shows a visualization of CO2 data, inside and outside temperature data, and inside/outside humidity data over a complete season 2012-2013.

Fig.25 - A 24hours webcam recording and realtime streaming is installed to follow at any time the activity in the Transparent Beehive. The camera is placed in front of the tube through which the bees have to pass to fly out for foraging. The upper left photo shows the early morning sunlight whilst the lower left picture is made in the late afternoon.

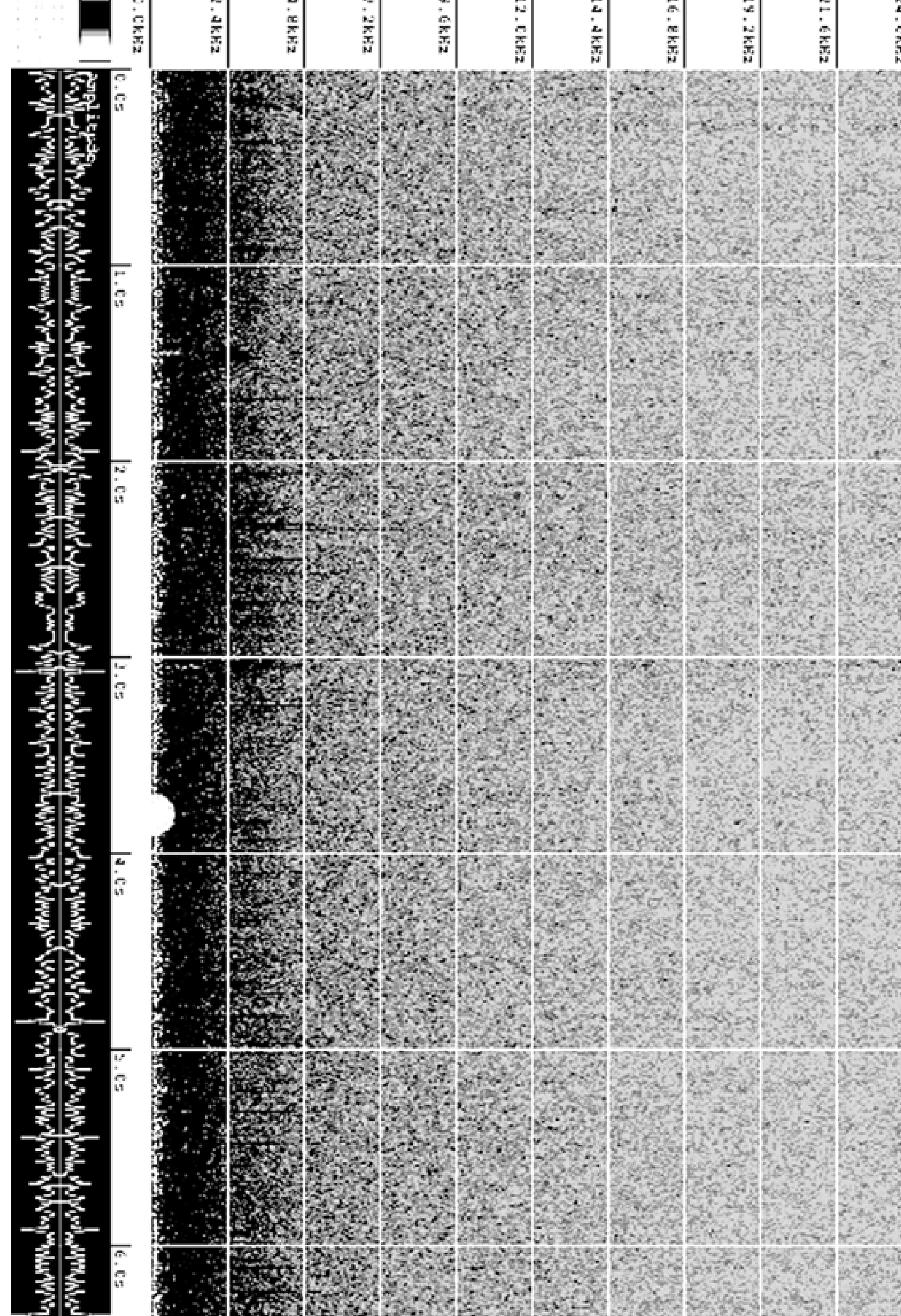


Fig.26
Related to the images, there are also the recordings of the subtle sounds of the bees running over contact microphones. These are attached inside the hive, between the comb, and between the wood of the frames and their aluminium border. One of the characteristics of the sensitive microphones is that they pick up and amplify all action from the surfaces on which they are attached.
The hustle and bustle of the colony is thus rendered in a performative sonification.
Analysis of the bees' biorhythm could be approached as music when visualized as a soundscore. Would it be cyclical? Expressed in waves of action?
Swelling, traversing and absorbing time, finally fading away in the heat of the late afternoon light?
For instance, meteorological facts influencethe bees' behaviour. A windy day makes them nervous, and an upcoming thunderstorm makes their dances even wilder.

Fig.27
Honeycomb is rendered using the 3D application Blender. I did this as a part of my research into the creation of a new design for beehives that takes into account the natural situations in which honeybee colonies live, including the parameters related to the biotic as well as abiotic properties of the situation such as altitude, electromagnetism, temperature, direction of the sun, the nest capacity, etc.

Fig.28 - Representing time lapse in the beehive: a single bees' trail over the honey comb is visualised as a result of superposition of images. Working with this kind of 'magnified' visual effects gives us an insight in the daily actions and tasks performed by the honey bees in the colony and inside the hive.

Fig.29
Visualisation of the webcam recording representing a season of bee monitoring,
The timeline view is generated by video database Pandora, and it shows at a glance the activity in the beehive.
All documentary movies on the bee monitoring project and the Transparent Beehive are archived in this open access video database and can be consulted online.

http://pandora.okno.be/grid/title/list==annemie:BeeMonitoring

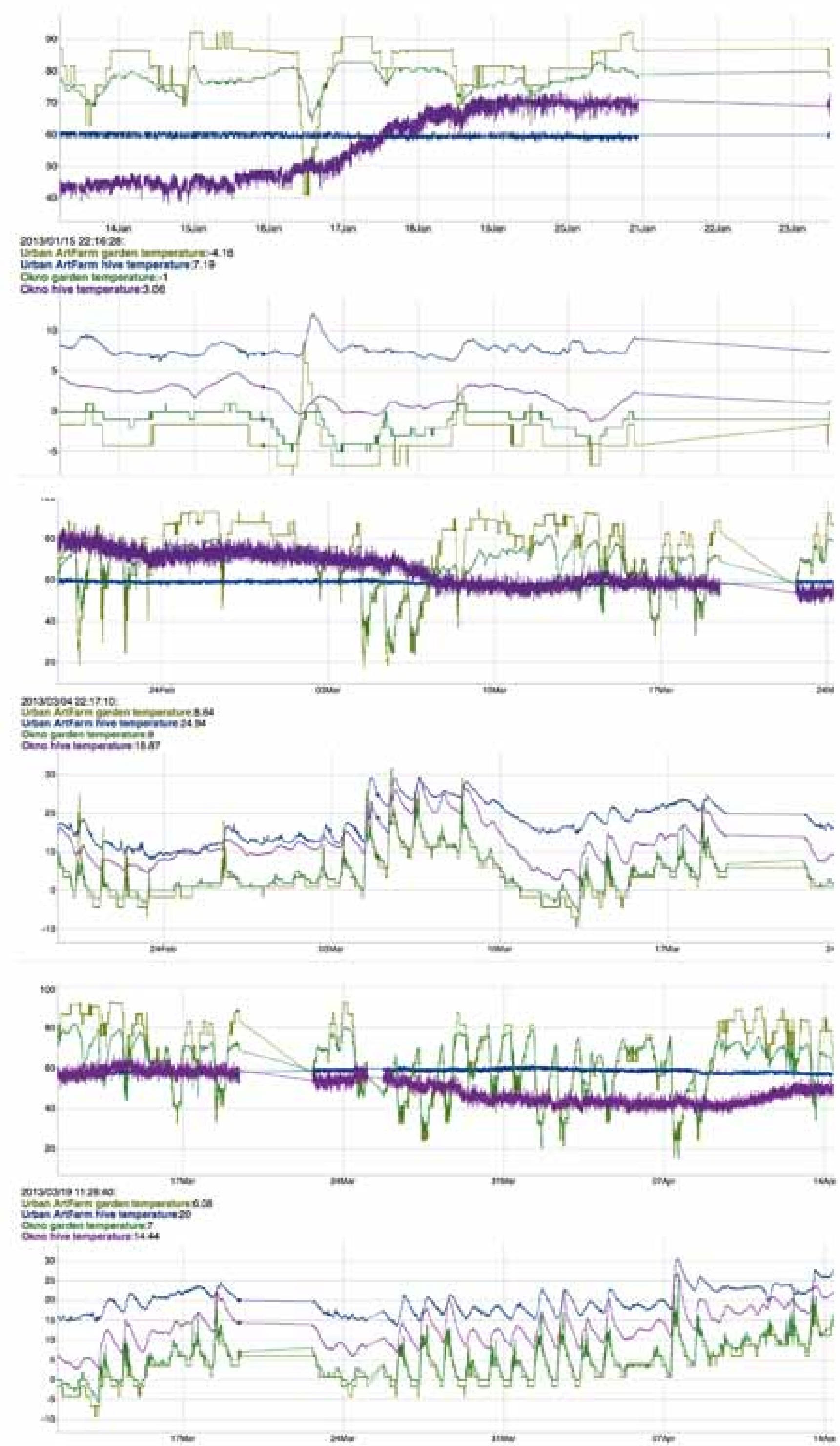


Fig.30
Autumn 2012. We develop a second [real time] visualisation system for representing the sensor data online.The graph compares data of beehives in different rooftop gardens in the Brussels city center. For both locations we register humidity and temperature inside the hives as well as outside. The visualisations show clearly the cycles of day and night. We see also that the temperature in the hives is influenced by the temperature [or solar radiation] in the gardens.

From this experiment I learned that it is not precise enough to work with one temperature sensor in the hive to measure accurately the temperature of the bee nucleus. The bees move through the hive, but the temperature sensor is fixed in the middle top bar. In winter, the bees have to be very economical in spending their energy. They keep the heat in the center of the bee nucleus, were the queen is. The outsides of the nucleus are many degrees cooler, and the empty spaces of the hive are not heated at all.

We need to find new methods for monitoring without opening the hives in winter. This experiment also taught us that we need more robust technology. We had server breakdowns, sensor malfunctions, and the overall equipment was not professional enough to yield reliable data.

Fig.31
Honey bees and pollen collected fresh from the rooftop garden and ready for dissection and examination with the scanning electron microscope [SEM] and the stero microscope. A study of the bees and the pollen will give us valuable information about our [urban] ecosystem: on plant diversity, air pollution, pesticides and fertilizers.

Fig.32
In august 2013 I was offered the possibility to work at the Chemical Engineering Lab of the VUB on the Scanning Electron Microscope [SEM] with which perfect 3D images at +20.000 enlargment scale can be made.
It is ideal for photographing pollen and bee-parts as proboscis, receptors, eyes , legs and antennae.

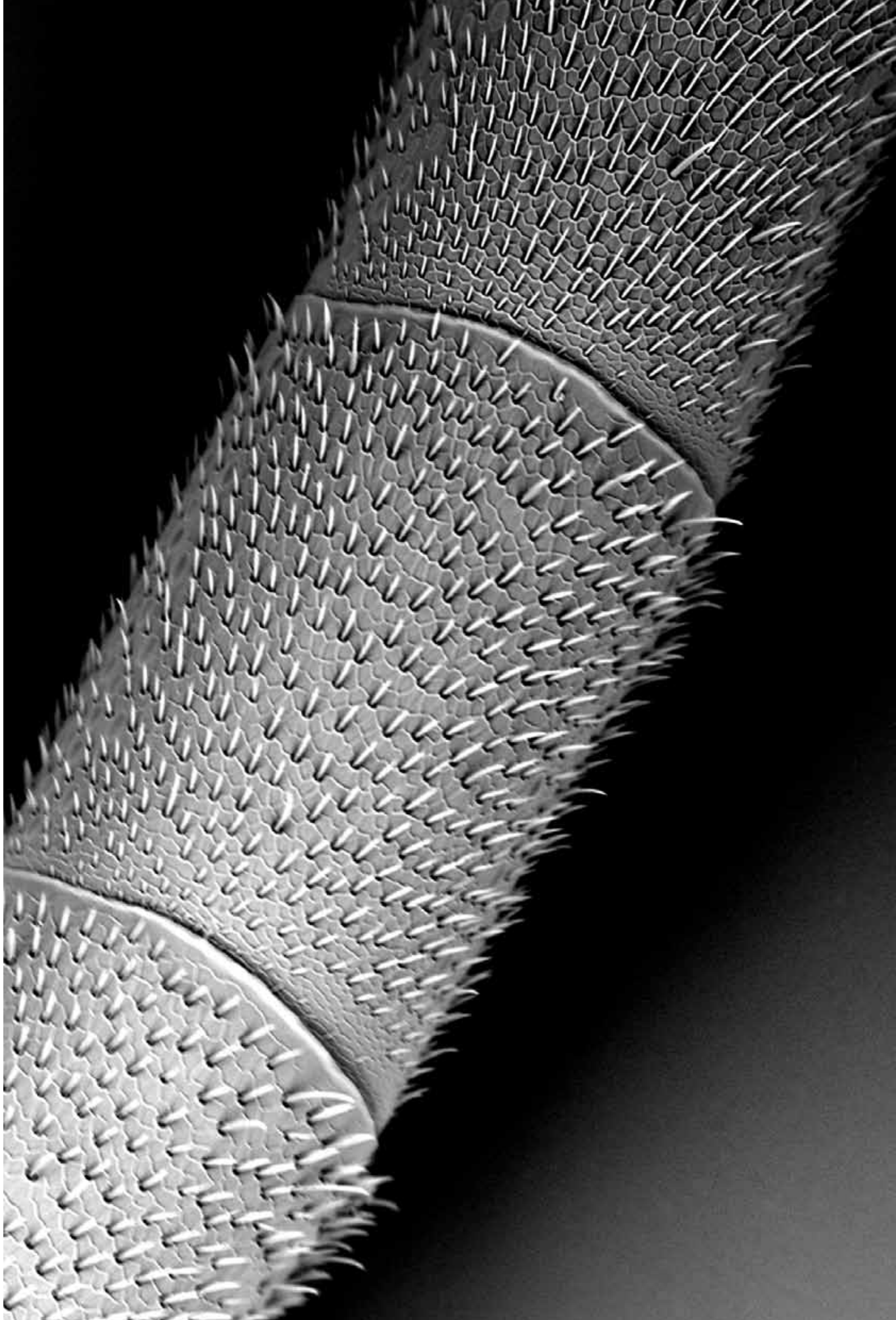


Fig.33
My first micro-photograph is a part of a bee-antenna.
The magnification factor is x 450 and the object is 590 micron long.
One micrometer (micron or mu) is a millesimal of a millimeter.
The antenna is covered with thousands of hairlike receptors,
the sensing organs of the honey bee.

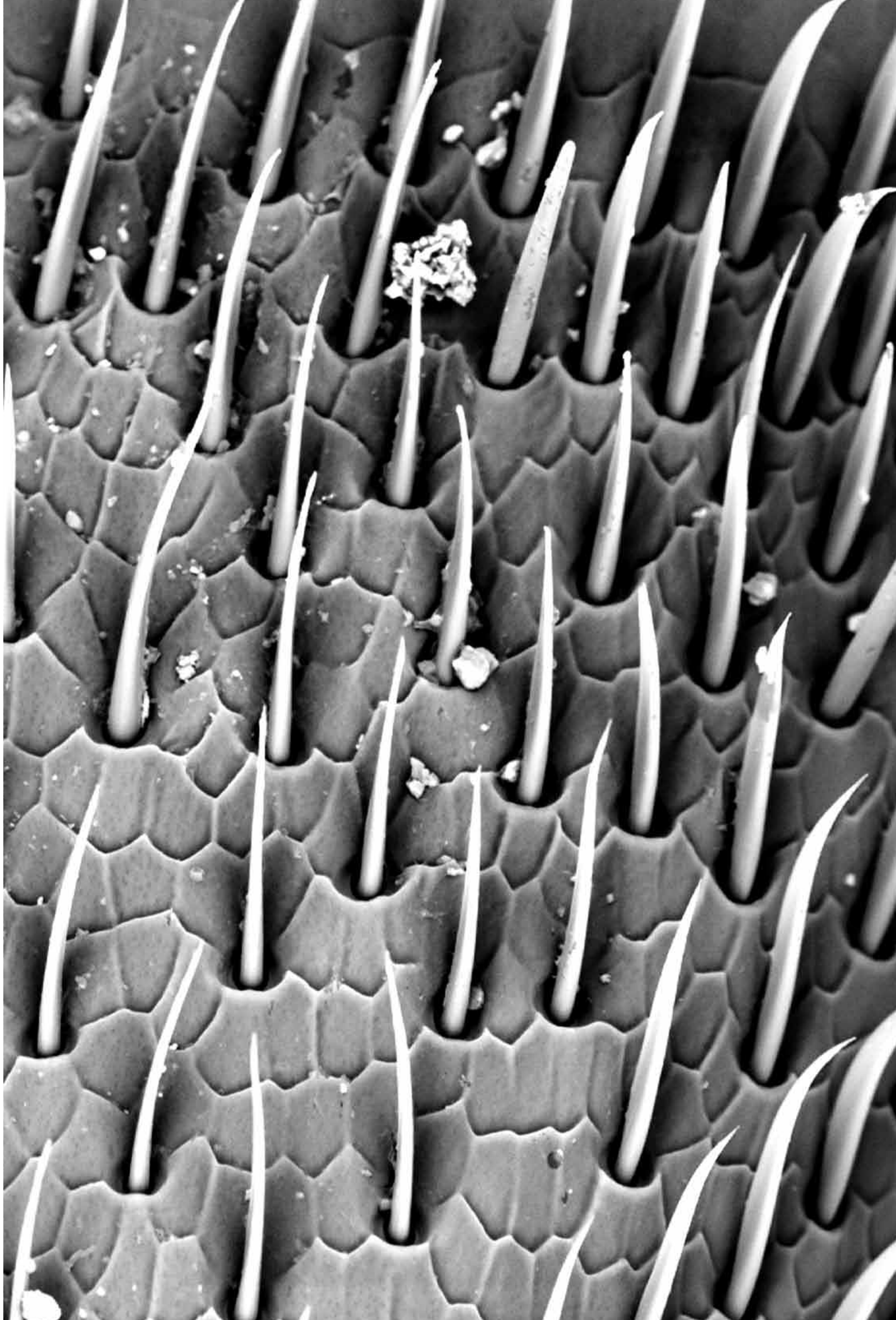


Fig.34
Smell and touch are more important for honey bees than visual information, as they spend a lot of their time in the dark corners of the hive.
The honey bee antennae accommodate thousands of sensory organs. Some are specialised for touch, some for smell and others for taste.
It used to be thought that honey bees couldn't hear any airborne sound because they do not have pressure-sensitive hearing organs [like our ear-drums]. Because of this, scientists were puzzled how the worker bees can perceive the buzzing sound produced by forager bees during waggle dances.
Recently it was discovered that bees can indeed 'hear' airborne sound in close range, through sensing the movement of air particles by the hairlike mechanoreceptors on the antennae.

Fig.35
There are 40.000 sensors on a bee antenna. These sensors, with which the bee detects the odors of the flowers, are located on the exoskeleton, as this is the boundary between the bee and its environment.
Most of the sensors are very small hairs, The bee can detect a spatial odor pattern -3D odor shape of the flower-.
It can distinguish different concentrations applied simultaneously to the 2 antennae. After landing on the flower, the antennae smell various odors on the way to the nectar.

Pollen grains are transported between the receptors on the antennae of a honey bee.
A honey bee has hairs all over her body, this makes it easy for the pollen to stick and thus they get a free ride to be delivered on the stigma of another flower of the same genus.
The aperture of the pollen is opening and the pollen tube is ready to come out for fertilisation.

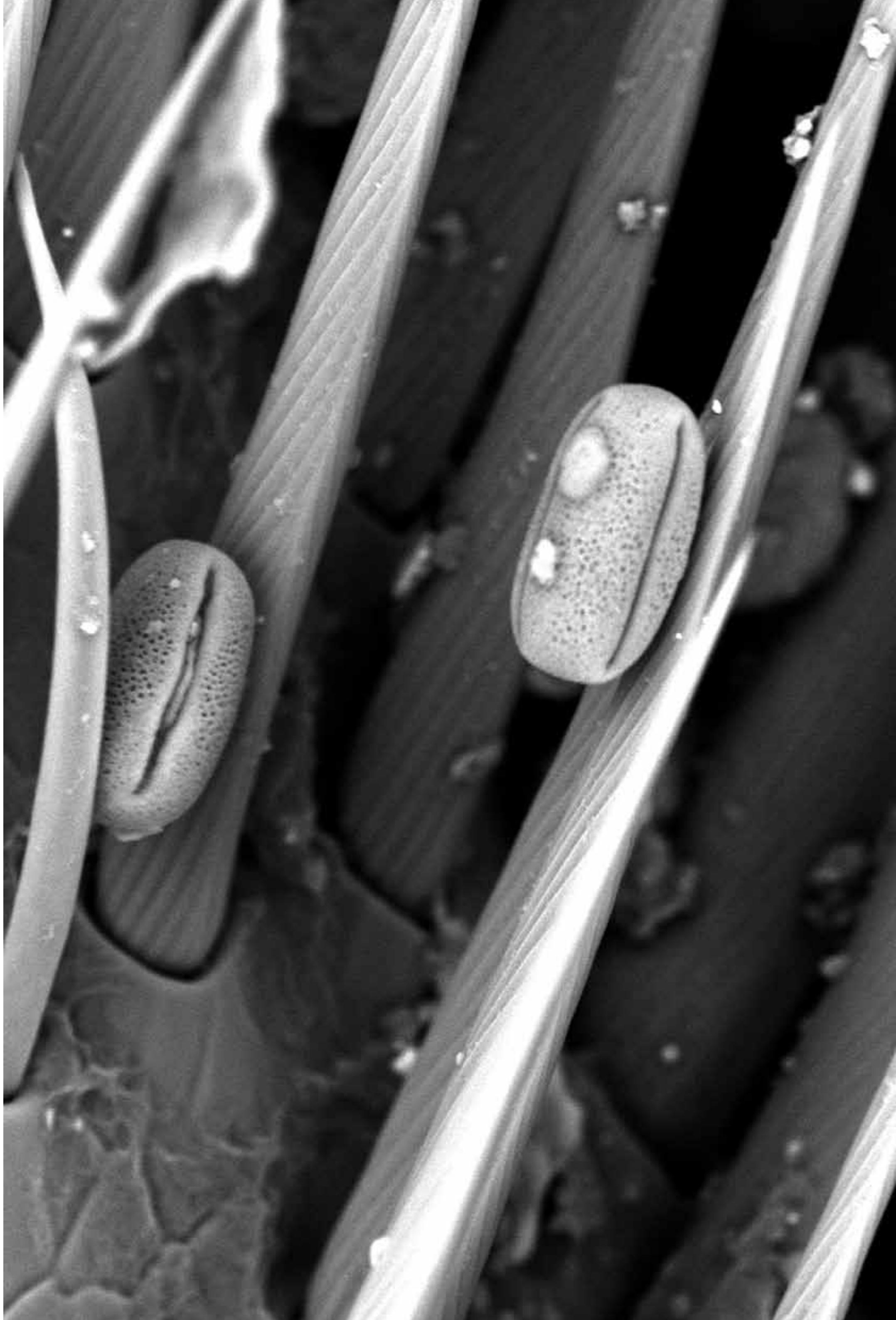


Fig.36
The bee's eyes differ greatly from human eyes.
They consist of a pair of compound eyes made up of numerous six-sided facets. They also have three simple eyes.
Despite this, their vision is sharp for a distance of only 1 meter.
A compound eye cannot register the fine detail of our own eyes, but it is particularly good at detecting and following motion.
Bees navigate by ultraviolet light which penetrates clouds and they use the sun as a reference point to communicate to other bees the angle of flight to be followed to arrive at newly discovered foraging fields.
Insects discover flowers from far way, either by smell, by vision, or by a combination of both senses.
The play of the flower and the bee, and the attractions by special colours, special shapes, special scents.
A very detailed account on this is given in the book Insects and Flowers: the Biology of a Partnership by Friedrich Barth.

Bees also see colours, a discovery by nobel laureate Karl von Frisch.
The colour spectrum of a honeybee is shifted compaired to the human visual spectrum.
Bees distinguish shorter wavelengths and the result is that they see ultraviolet but they can not percieve red.

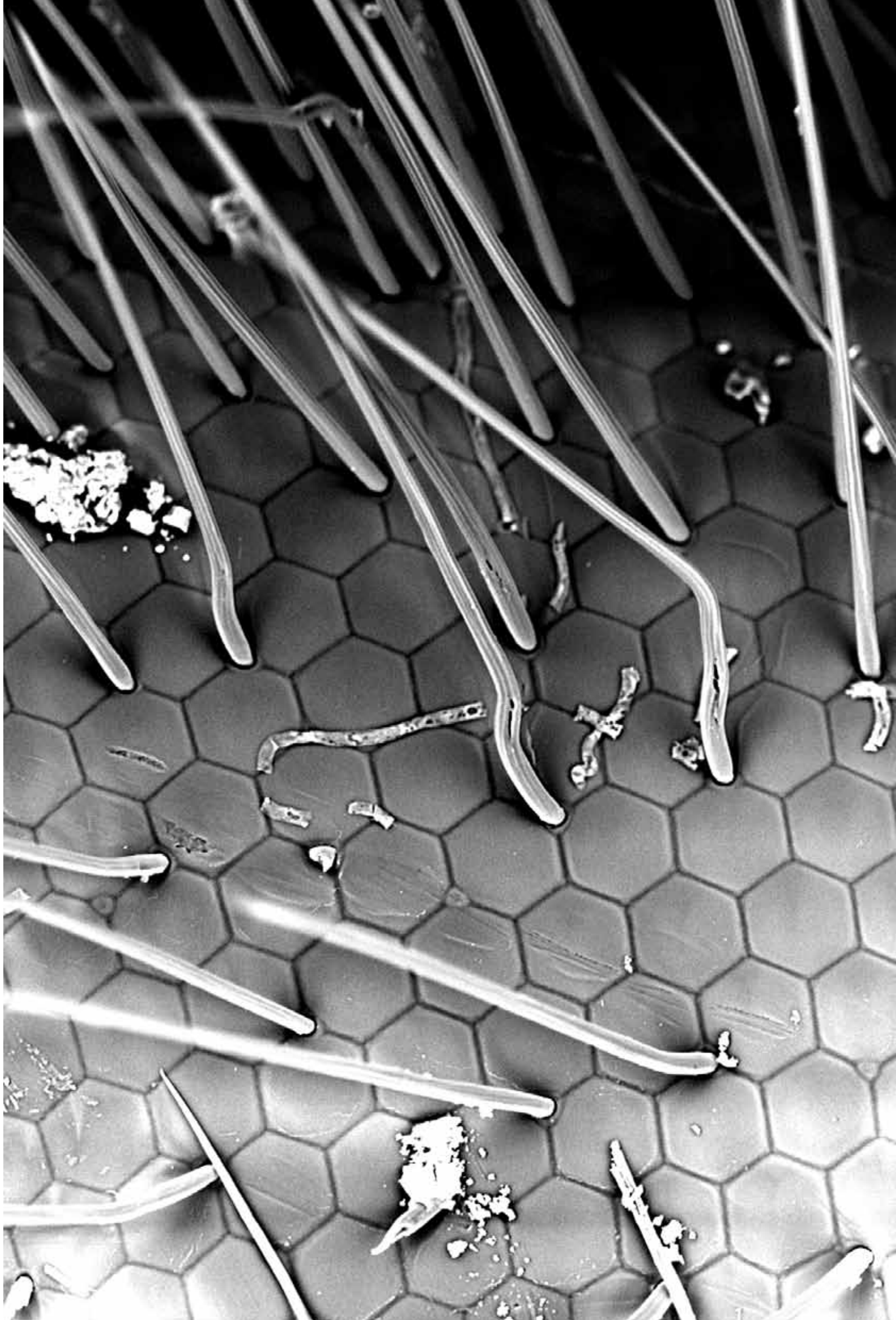


Fig.37
The proboscis is the combination of all mouthparts of a honey bee.
It is a long and complicated instrument that exists of 5 parts.
When it is not used by the bee, for example in flight,
it folds back like a clasp knife.
There is a pair of mandibles -the upper jaws-, these chewing tools
are used to eat pollen, build the comb and clean the beehive,
and to fight uninvited guests at the door of the hive.
Than there are the lower jaws, the maxillae.
The tongue is a long, straw-like instrument, covered with hairs with a
spoonshape end to suck the nectar.
Besides being a feeding instrument, the bee-tongue serves
also for licking the queens' pheromones which regulate
the life in the hive.
So it is also a kind of communication instrument.
The length of a sucking proboscis of a honey bee is 6,5 mm.
This is important for reaching the nectar position within a flower.

Proboscis photographed with stereo microscope, x20

Fig.38
The magnification of the proboscis opens a completely unknown world. Scary and fascinating - it makes me think of the jaws of a whale …
At the end of the proboscis -the 3fold bee tongue- we can see the honey spoons, the bee-instrument for collecting the nectar out of the flowers.
Pollen grains are hanging around everywhere.

Fig.39
Pollen grains are microscopically small, the details cannot be observed by the human eye.
The size of a pollen grain is measured in microns, a thousanth of a millimetre.
The grains are sticky and have an 'oily' coating on the outside, this makes it easier to stick on the body parts of the pollinating insects.
Pollen contain the sperm cells of the flower.
The hard pollen wall protects the cells from dehydratation and solar radiation on their trip to the female flower parts.
The colour spectrum of pollen is composed of a subtle variety, ranging from light to deep yellow and orange (when the cartenoid pigmentation predominates) to colourless and yellow (when the flavonoids predominate) and red and purple for the anthocyanins.
The exact colour of the pollen grain is produced out of a concentration mix of the different constituents and may vary between different species from the same genus.

239. *Prunus domestica* ssp. *domestica*
Plum
4–5 kk

240. *Prunus dulcis*
Almond
3–4 hhh

241. *Prunus laurocerasus*
Cherry laurel
4–6 kkk

242. *Prunus laurocerasus*
Cherry laurel 'Otto Luyken'
5–7 kkk*

243. *Prunus nipponica*
Japanese alpine cherry
3–4 k*k*k*

244. *Prunus spinosa*
Blackthorn
3–5 kkh

245. *Rosa* 'Ballerina'
Hybrid musk rose 'Ballerina'
6–10 kkk

246. *Rosa* 'Eddie's Jewel'
Rose 'Eddie's Jewel'
6–7 k

247. *Rosa* 'Flower Show'
Shrub rose 'Flower Show'
6–9 kk

248. *Rosa* 'Forever Amber'
Shrub rose 'Forever Amber'
6–9 k

249. *Rubus fruticosus* agg.
Blackberry
5–9 kkk

250. *Rubus idaeus*
Raspberry
5–8 kkk

251. *Penstemon* 'June Tune'
Penstemon 'June Tune'
7–9 k'k'

252. *Tropaeolum majus*
Nasturtium
6–10 kkk

225. *Calluna vulgaris*
Heather
7–9 hhh

226. *Erica herbacea*
Winter heath 'Myretoun Ruby'
3–4 kk

227. *Erica herbacea*
Winter heath 'Vivellii'
2–3 kk

228. *Lotus corniculatus*
Common bird's foot trefoil
6–9 hhh

229. *Trifolium hybridum*
Alsike clover
6–9 hk

230. *Trifolium pratense*
Red clover
5–9 hhk'

231. *Trifolium repens*
White clover
6–9 kkk

232. *Ulex europaeus*
Gorse
3–6 kkk

233. *Fagus sylvatica* var. *purpurea*
Copper beech
4–5 hhh

234. *Hyssopus officinalis*
Hyssop
7–9 k'

235. *Clarkia pulchella*
Clarkia
7–9 k'

236. *Prunus avium*
Wild cherry
4–5 khk

237. *Prunus cerasifera*
Cherry plum
3–4 khk

238. *Prunus domestica*
Wild plum
4–5 hhh

Fig.40 - A page from the Colour Guide to Pollen Loads of the Honey Bee, published by the International Bee Research Association in Cardiff, United Kingdom . © 2006 IBRA

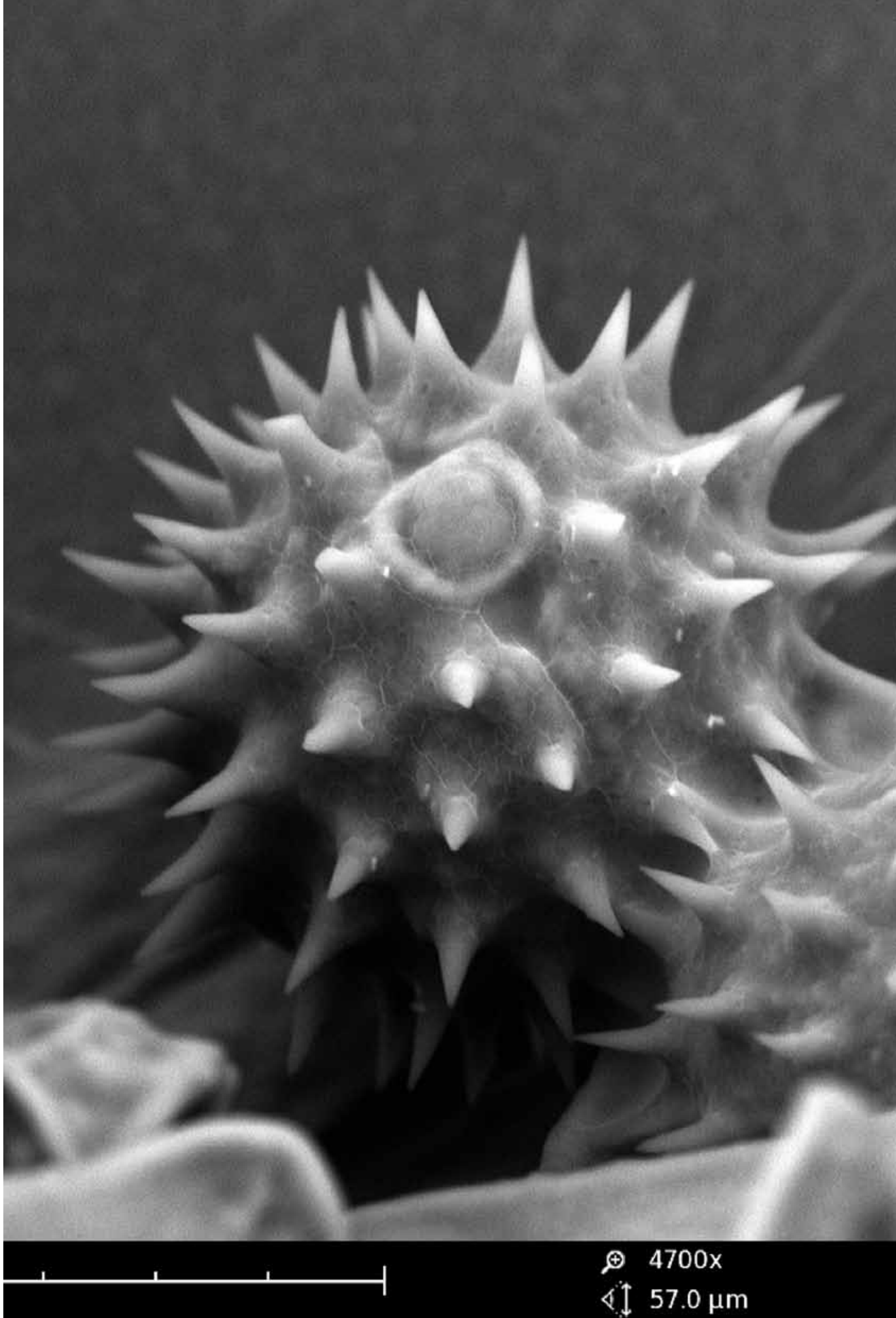


Fig.41
Helianthus annuus [sunflower] pollen grain.
Dimension: 57 micron, photographed with the scanning electron microscope x 4700.

There is a difference between fossiled or dried pollen and fresh pollen. For comparative pollen studies the pollen grains are prepared in the laboratory to highlight different features and to reveal the ornamented pollen wall because this is the part of the grain which provides the most of the characteristics necessary for determination.
Pollen grains can regularly be identified to family level and to generic level, and sometimes to species level.
Pollen and other microscopic particles are useful to monitor levels of atmospheric pollution.
In honey analysis the origin of the honey can be checked by the pollen it contains.

Fig.42
Dried Cucurbita pepo flower [Zucchini]. The pollen from this flower were used for analysis with the SEM microscope.

August 2013. The last few weeks I collected at regular intervals pollen at the entrance of the beehives.
We start to analyse them under the SEM. The microscope operates in steps. We have to zoom in more and more, one (big) step at a time.
The electrons are flying around and they are scanning the pollen.
The bundles of electrons are manipulated by electrical fields, they create a similar effect as lenses on light.
Finally the processed image is displayed on the screen.
There are different settings possible: TIFF and Jpeg, different resolutions. Max. is 2048. We can play with contrast and brightness.
When we go in higher magnifications, there is damage caused by the electrons. They are destroying our specimens!

Fig.43
The species of the Cucurbitaceae - the cucumber and squash family - have the largest pollen grains.
The pollen grains on the right, providing from the Cucurbita pepo [Zucchini] have a diameter of 394 microns.
They are photographed with the SEM microscope at magnification of x680.

Non-prepared pollen give a rather grey contrast when photographed with the SEM. Their skin is hard and soft at the time.
We are working with living material and sometimes the subject disappears while we try to photograph it.
Coating the subject with a ultra fine layer of gold or platina prevents damage from electrons being shot at them, and enhances the contrast at once.

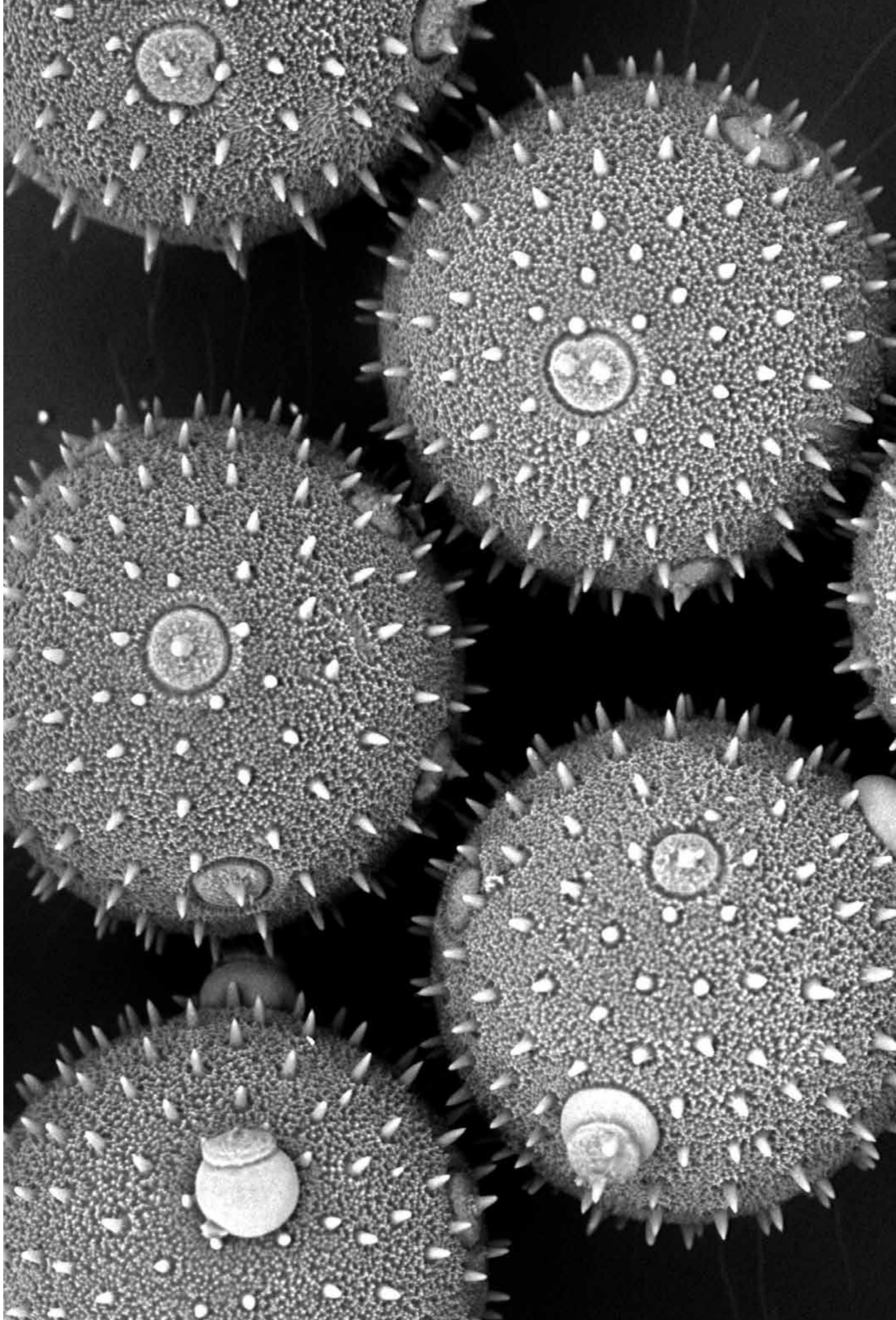


Fig.44
Hind leg of a bumble bee with a full pollen basket, photographed with a stereoscope x 30.
A stereoscope - also known as a dissecting microscope - magnifies between 10x and 70x and is suited for viewing 3 dimensional objects such as flowers and insects.
The specimens are lighted from above.
This bumble bee died [a natural death] in front of my stereoscope before she could deposit her pollen harvest at her colony's nest.

Fig.45
The pollen comb or pollen press, SEM x275.

A honey bee moistens the forelegs with a protruding tongue
and brushes the pollen that she has collected
on the head and the body towards the hind legs.
The pollen is transferred to the pollen comb and then combed,
pressed, compacted, and stored in the pollen basket situated on the
outside surface of the hind legs.

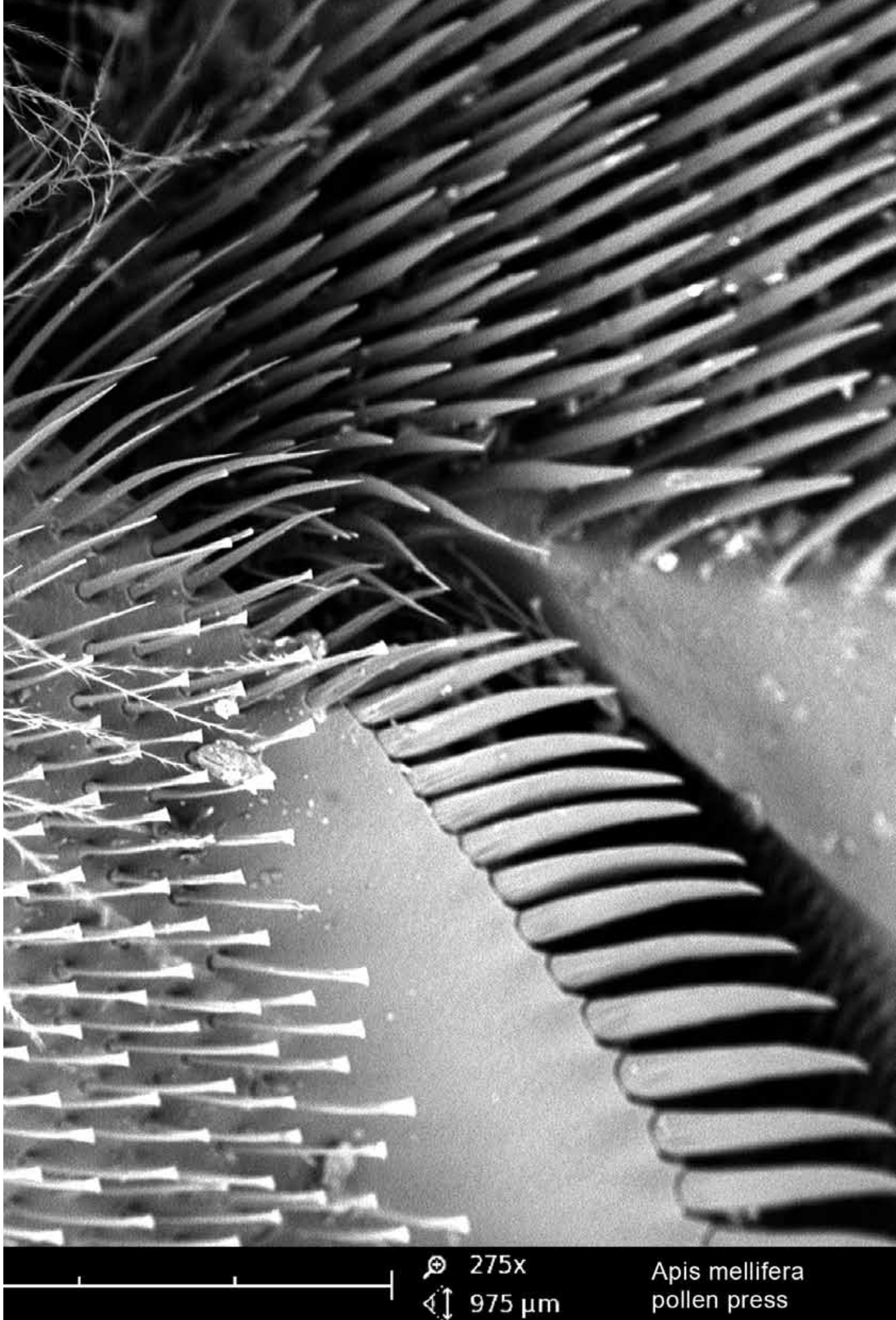


Fig.46
Mentha spicata [mint] is an excellent melliferous plant.
It flowers in august and september and it has a great pollen
and nectar value for pollinating insects, P3 + N3.

To compare the pollen brought back by the bees
and the plants in the garden in which the hive is located,
I assembled a combination of pollen from my herbarium
for analysis with the SEM.
I believe that in the spring the majority of pollen comes from
the salix family. They have a range of light yellow to greenish colors.
There is also a bright yellow pollen - probably the Taraxacum officinale.
Later in the season I have found olive green pollen:
Rubus, Viburnum tinus, Prunus avium, and
the yellowish green of the Malus domesticus.
Pollen from many more plants need to be examined:
The olive of the Prunus spinoza, the fresh green of the Sambucus
nigra, the darker green of the Vicia faba and
the olive green pollen of the Quercus robur.
I study all of these with the Scanning Electron Microscope.

Fig.47
An isolated pollen grain of Mentha spicata , Lamiaceae.
78,9 micron and 3400x magnified.
Photographed with the SEM microscope.

At the end of the first SEM day I come to the conclusion that it will be very hard to determine the pollen collected by the bees.
I need another method for verifying and comparing the pollen.
I will do a double check.
The next day I go out in the garden to collect pollen myself, straight from the flowers.
I collect Calendula officinalis, Fragaria, Borago officinalis, Fagopyrum esculentum, Mentha spicata, Helianthum annuus, Cucurbita pepo, Solidago canadiensis, …
At the VUB lab I make samples of this collection - dip the sticky tape in the pollen and put the sample on the little black dot that will be mounted in the machine to be scanned by the electrons.
Making a good sample is the basis of a good image.

Fig.48
Pollen grain of buckwheat [Fagopyrum esculentum, Polygonaceae], photographed on the anther of the flower.
Nectar value N5, pollen value P5.

There is indeed a big difference between fresh pollen and dried pollen from an herbarium.
The fresh pollen move: they implode, as they are deshydratating.
This happens via the pollen apertures, the slits we see in polar and equatorial view.
The pollen can swell again as well if necessary, for example when they arrive via pollination on the pistil of the (female) flower and they grow via the pollen tube and the style till they reach the ovary where fertilisation takes place.
A seed is born.

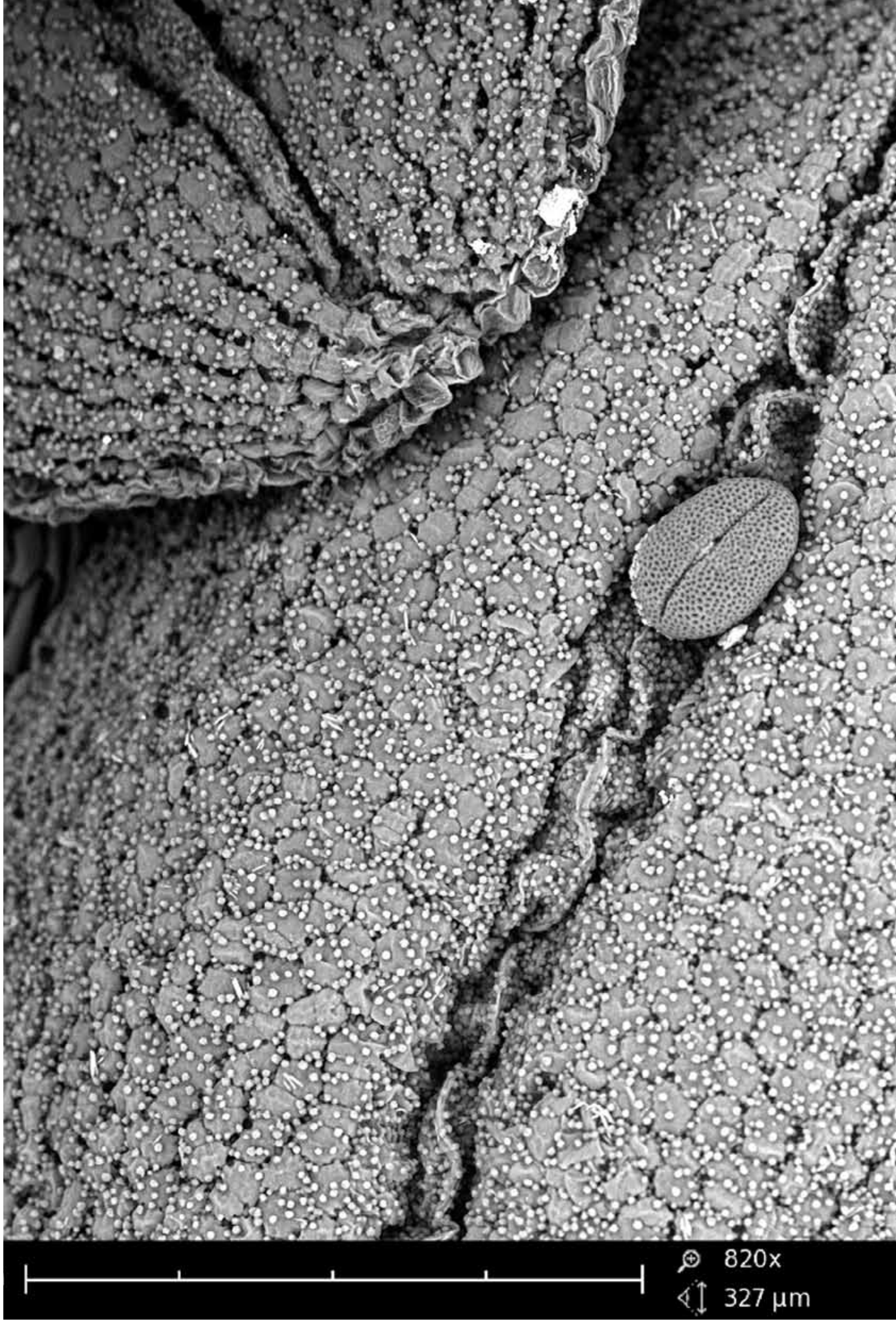
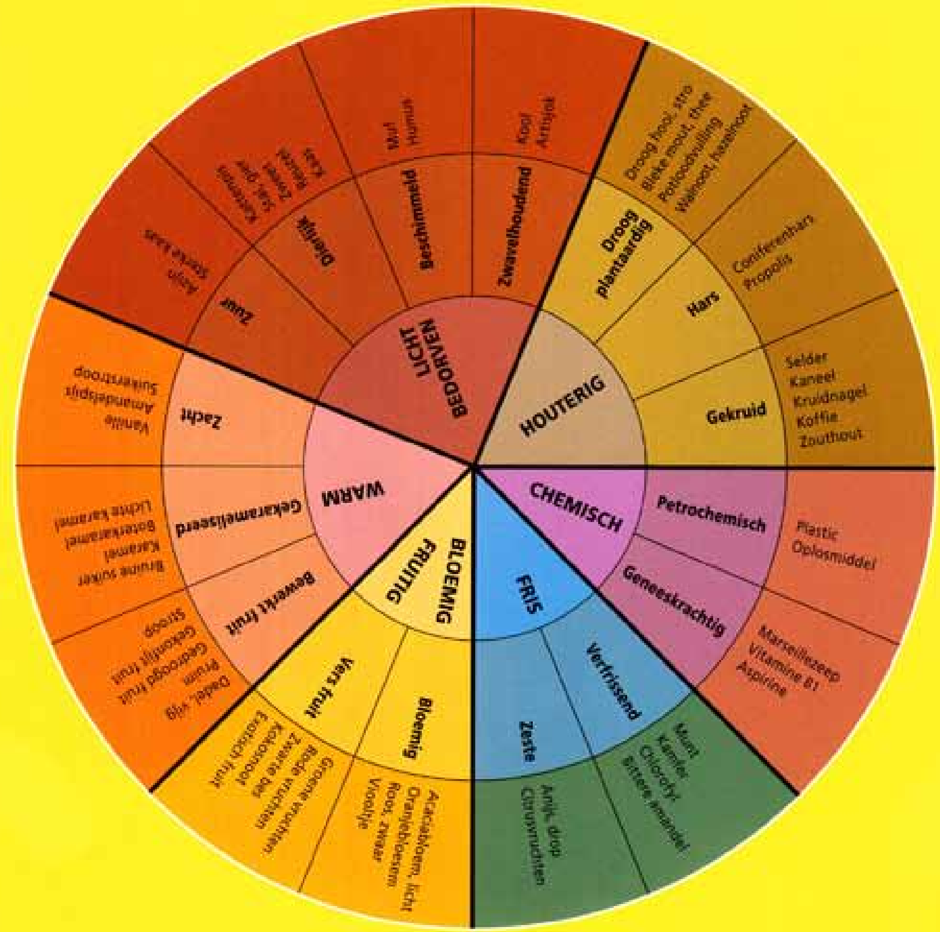


Fig.49
The Cari Honey Aroma Wheel (Centre Apicole de Recherches et d'Informations de l'Université de Louvain la Neuve) offers a method for interpreting the results of the honey analysis. The regular classification is done on the basis of the different pollen that are spotted in the honey. But at Cari they discovered that, even when very similar pollen, the honey can aniway differ a lot in taste and in color. Thus they decided to work with a complementary classification method, based on aroma's. They work with a sensorial approach to describe the taste of the honey, similar to descriptions of wines or perfumes. The reason why Cari developed this additional classification for honey, is that some of the melliferous flowers don't leave a lot of pollen to the sticky hinge legs of the bees. Hence the pollen of these flowers are not represented in the honey, but the nectar of these flowers is a part of the honey composition. The sensorial tasting is as such a good complementary classification.



Rapport d'essai

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e-mail : info@cari.be
http://www.cari.be

Accrédité selon la norme ISO 17025
Certificat n°312-TEST

Louvain-la-Neuve, le 13/12/2010

OKNO asbl

MAES Annemie
Quai aux Charbonnages, 30

1080 BRUXELLES

Informations transmises par l'apiculteur:
Vos références: OPEN GREENS
Flore annoncée : Bruxelles ville
Période de récolte: de printemps
Lieu de production: Bruxelles

Informations du laboratoire:
Miel n° 1011760
Reçu au laboratoire le 17/11/2010

1. EXAMEN PHYSICO-CHIMIQUE

Méthodes adaptées d'Apidologie, 1997, Special Issue
Norme légale : AR relatif au miel du 19/03/2004

Validations des résultats IF

a) Essais accrédités selon la norme ISO 17025:2005

◉ **Humidité** (%)	16,73	± 0,2	*Mesuré par réfractométrie à 20°C* *Analysé le 22/11/2010* Seuil conseillé ≤ 18 % Norme légale ≤ 20 %
◉ **pH et acidité**			*Mesuré par pHmétrie et titrage au NaOH* *"non détecté" : Acidité libre ≤ 1,5* *"non quantifié" : 1,5 < AL ≤ 3,5* *Analysé le 23/11/2010* Acidité libre : Norme légale ≤ 50
pH	4,4	± 0,2	
pH au point d'équivalence	6,6	± 0,3	
Acidité libre (AL) (méq/kg)	5,9	± 1,05 (si AL < 40) ± 2,20 (si AL > 40)	
◉ **Conductivité** (mS/cm)	0,22	± 0,01	*Mesuré par conductimétrie à 20°C* *Analysé le 24/11/2010* Norme légale Miel de miellat ≥ 0,8
◉ **Indice de saccharase**	12,4	± 1,9	*Mesuré par spectrophotométrie à 400 nm* *"non détecté" : IS ≤ 0,9* *"non quantifié" : 0,9 < IS ≤ 2,1* *Analysé le 19/11/2010* Seuil conseillé IS >10 et si IS< 10, ID/IS ≤ 2,5
○ **HMF** (mg/kg)		± 1,9	*Méthode de Winkler* *"non détecté" : HMF ≤ 1,2* *"non quantifié" : 1,2 < HMF ≤ 3,5* Norme légale HMF ≤ 40 miels tropicaux ≤ 80
○ **Indice diastasique** (échelle de Schade)		± 2,8	*Méthode Phadebas* *"non détecté" : ID ≤ 0,26* *"non quantifié" : 0,26 < ID ≤ 1,88* Norme légale ID > 8 ou miel d'agrumes... ID >3 si HMF < 15 mg/kg

Les résultats ne sont représentatifs que de l'échantillon transmis au laboratoire. L'échantillonnage est de la responsabilité du demandeur.

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Fig.50
Melissopalynology is the study of pollen contained in honey and, in particular, the pollen's source.
By studying the pollen in a sample of honey, it is possible to gain evidence of the geographical location and genus of the plants that the honey bees visited,
although honey may also contain airborne pollens from anemophilous plants, spores, and dust due to attraction by the electrostatic charge of bees.

b) Essai non accrédité

Miel n° 1011760

Sucres (% matière fraîche)

Chromatographie en phase gazeuse
Analysé le 24/11/2010

Monosaccharides

Fructose	34,97	± 3,32
Glucose	29,36	± 2,14
Frutose/Glucose	1,19	

Disaccharides			**Trisaccharides**		
Maltose + indét.	5,52	± 1,32	Raffinose	0,09	± 0,12
Turanose + indét.	2,08	± 0,64	Erlose	1,23	± 0,16
Mélibiose et isomaltose	0,74	± 0,38	Mélézitose	0,05	± 0,40
Saccharose	0,23	± 0,10	Maltotriose	0,14	± 0,32
Tréhalose	0,00	± 0,10	Panose	0,20	± 0,59
Gentiobiose	0,00		Isomaltotriose	0,00	± 0,09
Palatinose	0,00	± 0,08			

2. Examen pollinique (non accrédité)

Acétolyse selon Erdtman G. 1969. Handbook of Palynology.
Munksgaard, Copenhagen, 486 p.
Analysé le 26/11/2010

Analyse pollinique

Densité générale	Moyenne
Pollens dominants	
Pollens d'accompagnement (de 10 à 40 %)	Saule (17%), Ronces (30%), Fruitiers (39%)
Pollens isolés (<10%)	Poacées, Bouleau, Brassicacées, Trèfle, Marronnier, Rosacées, Caprifoliacées
Pollens isolés significatifs	
Elements figurés	

3. Examen organoleptique (non accrédité)

3.1. Présentation

Examen visuel	Homogène	
Couleur:		
miel liquide (Pfund)		
miel cristallisé (Pantone)	121	Jaune Clair

Consistance de l'échantillon:

à son entrée au laboratoire	Onctueux
à sa sortie	Onctueux
Cristallisation	Imperceptible
Sablage	Granuleux

3.2. Profil odorant et gustatif

Légende Contribution à l'intensité 1: mineure 2: de base, 3: dominante

Odeurs

		type d'odeurs
Intensité	discrète	*Chaude*
		Flor./fruit.
		Boisée

Arômes

		type d'arôme, évoquant
Intensité	moyenne	
Chaud	3	⇒ *Caramélisés* ⇒ *caramel léger*
Floral/fruité	1	⇒ *Floral - Fruité* ⇒ *fruits*
Frais	1	⇒ *Zeste* ⇒ *zeste*
Chimique*	2	⇒*Médicament*
Boisé	1	⇒ *Végétal sec et épicé*
Avancé*		

Saveurs et sensations

Saveurs	Intensité	moyenne
	Sucrée	2
	Acide	2
	Amère	
Sensations	Astringente	2
	Froid	
	Piquante	

Arômes, sensations exogènes

1 ⇒ Cire d'abeilles

Persistance 2

Les résultats ne sont représentatifs que de l'échantillon transmis au laboratoire. L'échantillonnage est de la responsabilité du demandeur.

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Fig.51
The local city honey is a precious product and very sought after. It is a perfect produce to exchange in the local gift economy.

Fig.52
The link between plants and bees is a vital one.
A map of melliferous plants in the urban space has to be drawn.
It is up to the beekeeper to keep track of the flowering periods
of all honey plants within the bees' radius.
Wild flowers are an important source of nectar and pollen,
which is essential for the honeybees in the late summer months
when the melliferous trees stop blossoming.
We find them often on wastelands, on building sites
and on track-sides or in parks.
Together with my friends and colleagues from the
okno art collective we make seed balls and spread
them around in vacant areas of the city,
thus reclaiming a small part of the urban public space.
This gives the bees a helping hand to stock up for winter.

INTERPRÉTATION DES RÉSULTATS D'ESSAIS

Nous avons interprété les résultats des essais réalisés sur votre miel, ce qui nous a permis de déterminer son origine et de vous conseiller pour sa conservation.

Miel n° 1011760

Vos références: OPEN GREENS

Interprétation des résultats : HD-EB

INFORMATIONS TECHNIQUES	INFORMATIONS CONSOMMATEURS
Humidité : Miel sec	**Type de miel : Toutes fleurs** Origine botanique : Saule, fruitiers, ronces...
Enzymes : Teneur en saccharase normale Commentaire : Miel à la cristallisation granuleuse. Les arômes médicamenteux proviennent du saule.	Origine géographique : Bruxelles Condition pour une conservation optimale à moins de 20°C À consommer de préférence avant fin juin 2012 Période de récolte: de printemps
ODEURS Intensité	
☒ chaude ☐ chimique* ☐ exogène ☒ flor./fruit. ☒ boisée ☐ fraîche ☐ avancée*	Intensité des odeurs **discrète**
ARÔMES Intensité	
☒ Chaud ⇒ caramélisés ⇒ caramel léger ☒ Floral/Fruité ⇒ floral - fruité ⇒ fruits exotiques ☒ Frais ⇒ zeste ⇒ zeste ☒ Chimique* ⇒ médicament ☒ Boisé ⇒ végétal sec et épicé ☐ Avancé* **Les notes "chimiques" ou "avancées" sont liées à la flore butinée par les abeilles, mais ne résultent en aucun cas d'une contamination exogène*	Intensité des arômes **moyenne** Saveurs et arômes : **Miel tannique aux notes de zeste**
SAVEURS ET SENSATIONS Intensité	
☒ Sucrée ☒ Acide ☐ Amère ☒ Astringente ☐ Froid ☐ Piquante	Intensité des saveurs et sensations **moyenne** **L'échantillon analysé répond aux normes légales et aux critères de qualité conseillés**
ARÔMES, SENSATIONS EXOGÈNES ⇒ Cire d'abeilles **PERSISTANCE**	L'échantillon analysé répond aux spécifications APAQ-W (humidité ≤ 18%)

Les résultats ne sont représentatifs que de l'échantillon transmis au laboratoire. L'échantillonnage est de la responsabilité du demandeur.
FE.LAB.8.1/Rév.5 *Seule la reproduction intégrale de ce rapport d'essai engage la responsabilité du CARI.* *page 3/3*

Fig.53
I monitored the development of the colony since its introduction in the hive. The images are continuously displayed on multiple flat screens and can as well be consulted in real time via the internet.
We made the sensor data information available on the images. Values are linked by time stamps. At one of the okno workshops, I assembled a costum made computer with the help of some technologists in order to display the information on four screens at once.

Fig.54
Summer 2013 I try to make X-ray images from a honeybee.
At the UZA (university hospital of Antwerp) I can collaborate with the professionals working at the medical imaging department.
During several hours we work on the x-ray table with a worker bee and a dead queen.
It is very difficult to get a clear image, the body of the bees is too transparent to get a good contrast.
The x-ray operator gives me a test-tube filled with iodium.
I will apply this on different parts of the bee (wings, thorax, abdomen) in different resolutions.
Later we will make new images.

Fig.55
August 2011 I follow an additional bee keeping course at the Zoophysiology department of the University in Ghent. During this crash course we are introduced to specific methods for studying bee behaviour. We can work in the bee observation room. The room is heated to a constant temperature of 35°C. The walls are covered with aluminum foil, to distribute the light in a very equal way. The overall light is a combination of 3 sources : 3 TL-bulbs, each of them flickering at a different frequency to add up to an equal distribution of brightness at 300 frames a second. 300 frames a second, that's the speed at which images are seen by a honeybee in flight. When the bees are perfectly comfortable in an environment simulating their natural one, the scientists can execute tests with artificial flower scents. On the wall are strips covered with artificial scents representing specific flowers. The bees are marked with fluorescent paint to track them during the experiments.

Fig.56
In nature, honeybees use a combination of visual stimuli and floral odours to locate a flower for the first time. Degradation of an odour source by pollution could result in a greater dependence upon other senses critical for foraging behaviour, such as vision, to compensate for the reduction in olfactory stimuli. Honeybee pollination can significantly increase the yield of crops. But to forage effectively, honeybees need to be capable of learning and recognizing the plants floral odour blend. Constituents of airborne pollutants may be capable of disrupting the odour recognition process that odour guided pollinating insects rely on for location of floral food resources.

3. working with bees

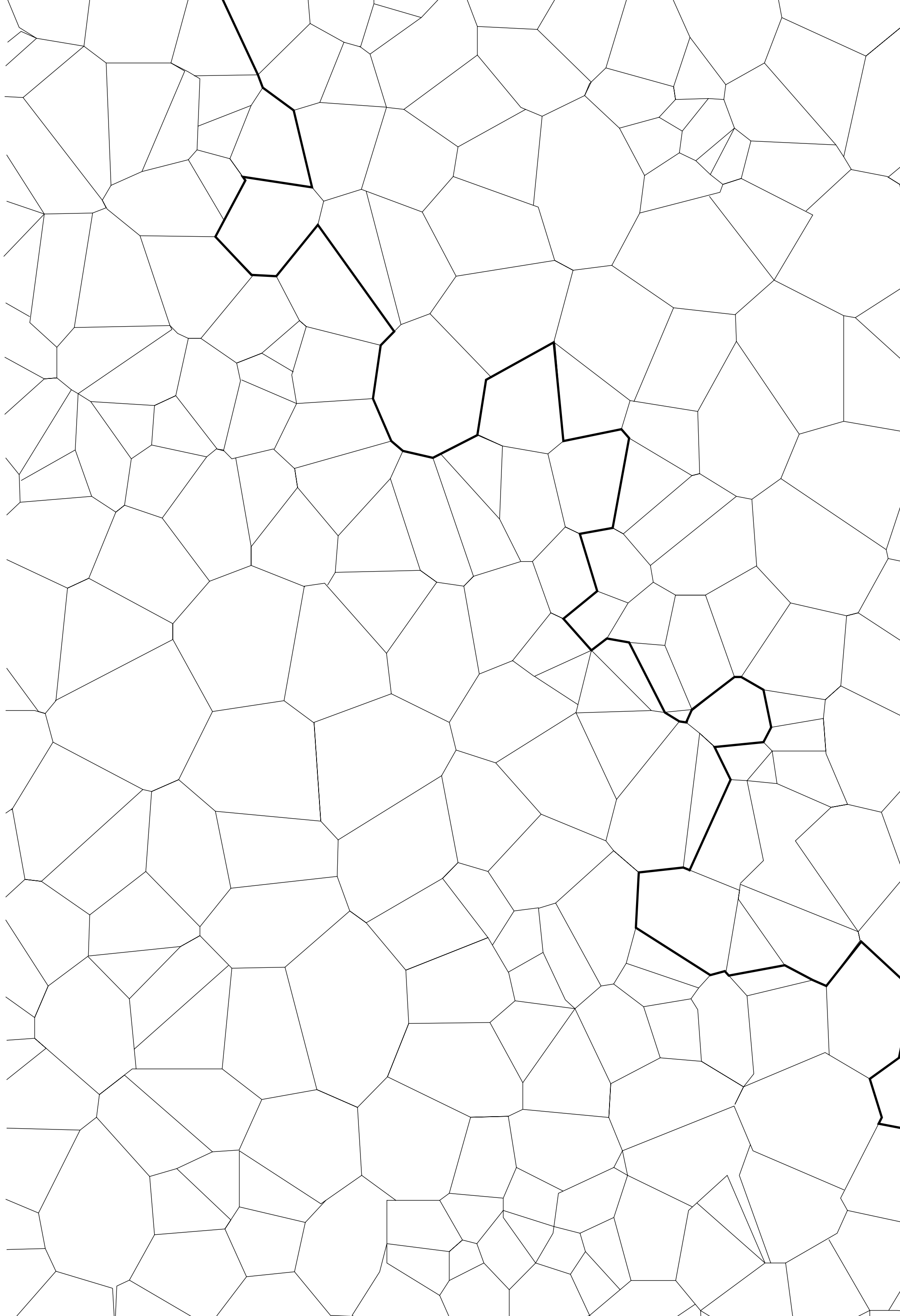


Fig.57
The beehive is set in an experimental garden,
where I work with natural processes.
The OpenGreens Gardening project is a very productive basis for looking into micro-sociological and ecological systems and for the development of artistic practices. Using media technology and electronics as research tools in the gardens as 'open green' shared laboratories, data from various ecosystems are collected over a period of time.

Computer generated Voronoi diagram representing the diffusion of plants.

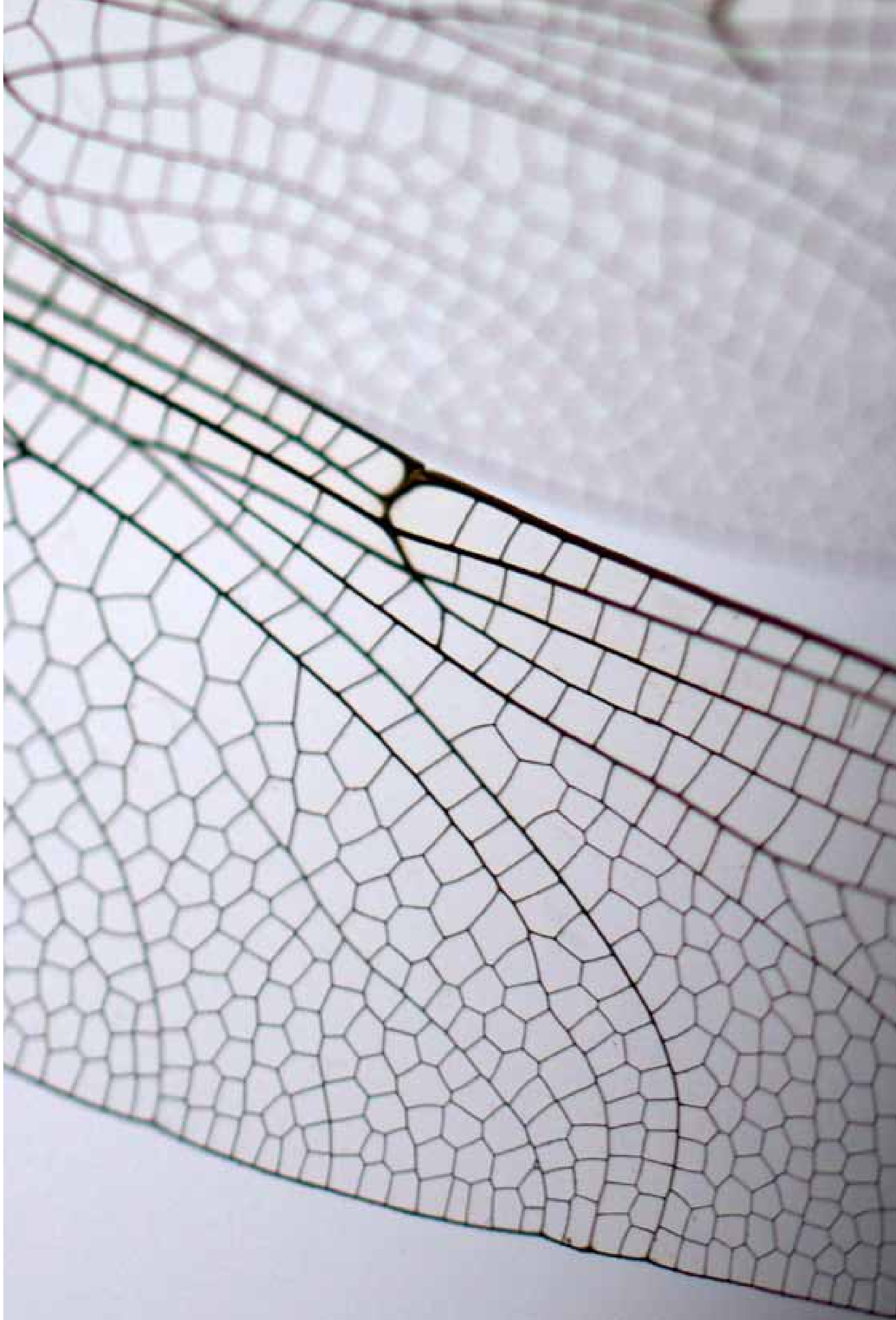


Fig.58
There are many synonyms for OpenGreen:
the experimental Hortus, the OpenAir Laboratorium,
the Vivarium, the Cabinet of Wonders.
But all OpenGreens are zones where culture and
nature overlap and where these two enter into a symbiotic
relationship with research and experimentation.
In the OpenGreens, I document the beauty of nature in data. I classify
and archive my notes and findings in OpenGreens databases.
I compare and develop concepts, interpret complex biotic shapes and
research repetitive natural patterns.
I connect nature with media art.

Wings of the Aeshna juncea [dragonfly].

Fig.59
June 2011. I experiment with contact microphones in the beehives.
Two piezo sensors are inserted into the hive: one in between the comb frames, and one right in front of the entrance on the landing platform. To enter the hive, the bees are obliged to walk over this flat surface and their trippling sounds are picked up and amplified in the recording. The piezo's are connected to a small mixing panel, an amplification is needed to normalize the very low soundlevel.
I record the activities on video, and the images show very clearly the relation between the sound and the bees' actions.
The results are encouraging.
Goal: make sound performances together with the bees.

Fig.60
The bees land on the pick-up microphone before entering the hive.
Instead of the usual buzzing bee sounds, we hear now a light toddling -
a sound score linked to the bees' action.
Knowing that the weight of a bee is about 90 milligrams,
the sound has to be amplified to become audible.

Fig.61
April 2012. The experiments carried out the previous summer are repeated in a more elaborated way and implemented in the Transparent Beehive.
Every motion in the hive results in a vibration in the air or on the surface of the comb.
A lot of things that go on in the hive can be explained by specific sounds, as for example when there is a new queen to be born - the old and the new queen will go into a 'dialog' (before trying to kill each other).
A queenless colony will make different sounds than a healthy functional colony.
When the bees prepare for swarming, there is a raised activity that is also audible.
But what interests me in the sound experiment is not so much the bees' behaviour, but more the overall development of the colony and the sonification of this long term process, on the basis of occupation of space in the beehive -which acts than as a resonance box- as well as the incapsulation of the pick up microphones with wax.

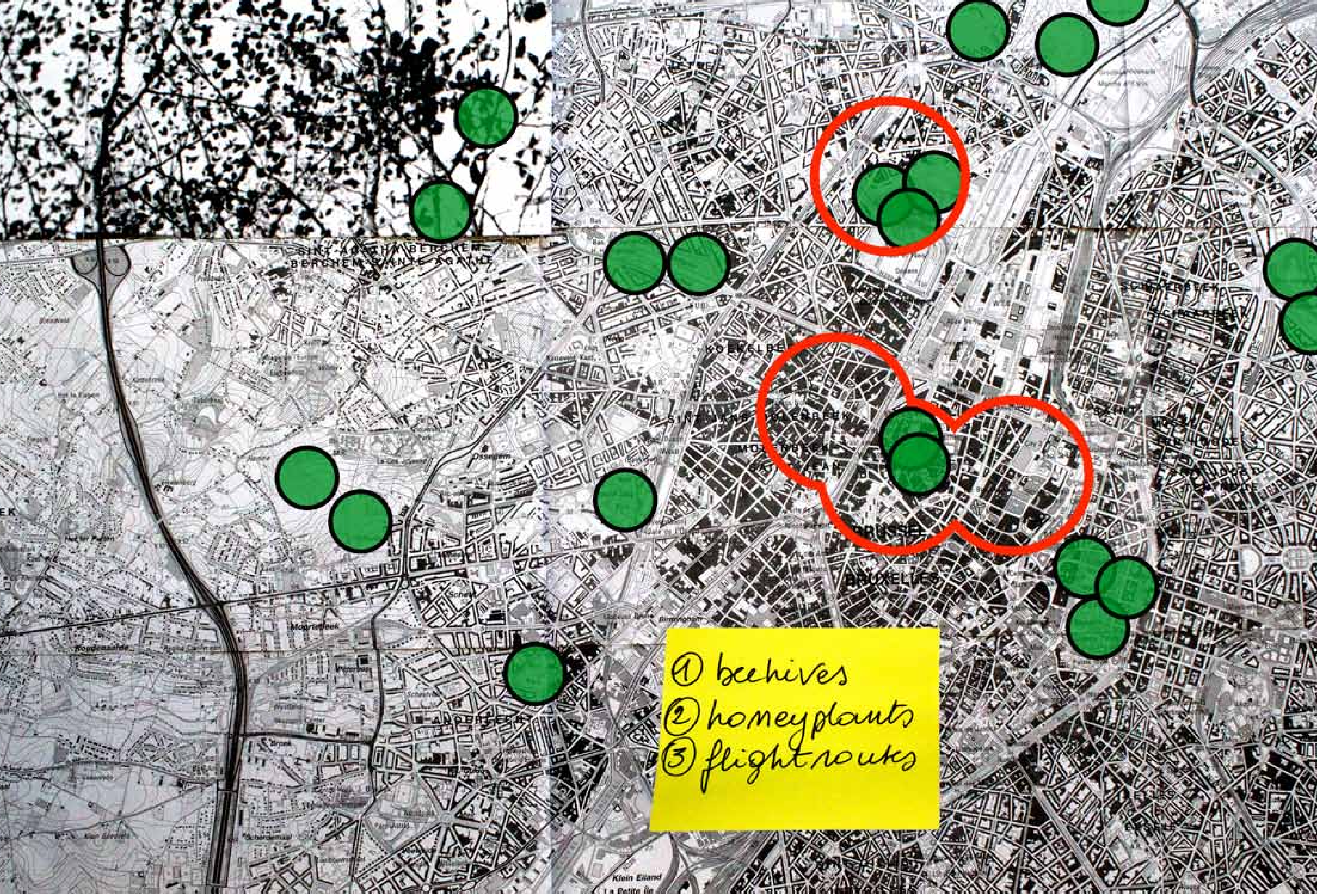


Fig.62 - Every beehive is a node in the ever expanding green corridors of the city. Corridors are ephemeral living structures in the form of green spaces connected through animal life. They are set up and maintained by urban communities to regenerate areas of the city, particularly areas which are subject to social and urban stress.

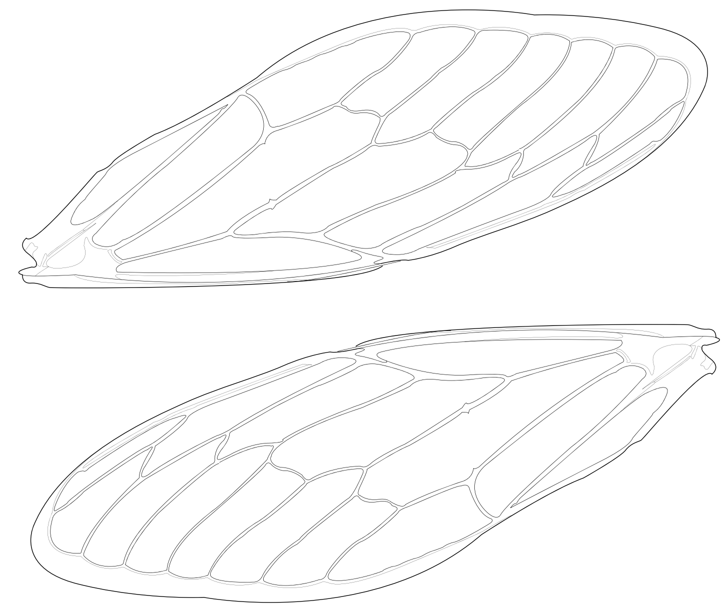


Fig.63
Some worker bees have a role as 'heater bees'.
They can dislocate their wings from their flight muscles and shiver with those large flight muscles to generate heat.
That's how they keep up the temperature in the hive, especially in winter.
Even at -15°C they keep the center of the hive up to 33 degrees and this is one of the facts that I try to monitor from a distance, without opening the hive

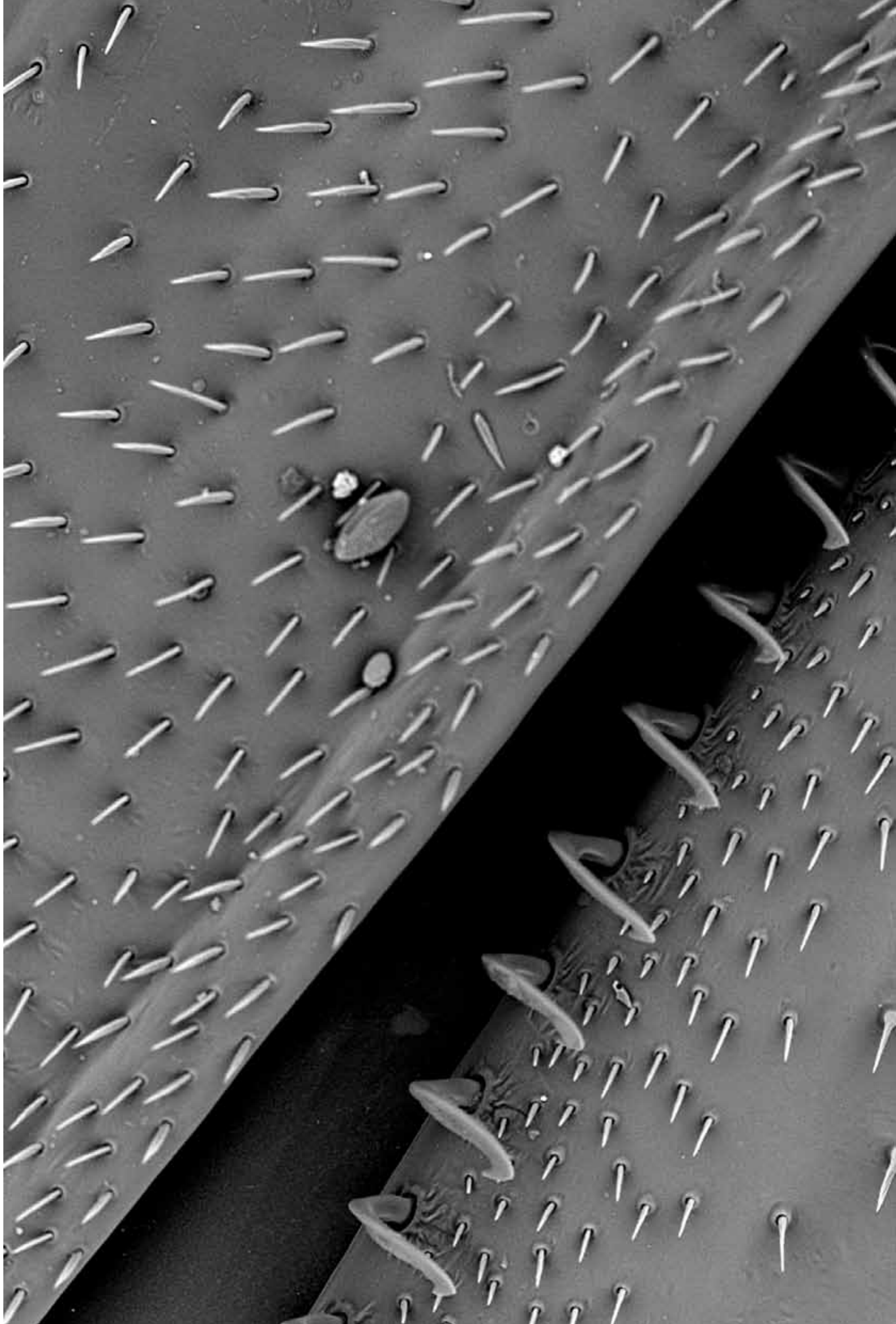


Fig.64
The wings of the honeybee have a very specific design and their flight mechanism is an example of delicate technology.
A bee carrying a load of nectar and pollen would require a wing too large to allow it to enter many of the flowers it collects from.
Therefore the honeybee is equipped with a double wing.
When flying, the two parts hook together with some kind of Velcro-system. And they fold neatly into one wing when reaching the flower to collect the nectar.

Fig.65
History shows that beekeeping is of all times.
In ancient times, the bees were perceived as
the female strength of nature.
Not only do they produce the golden honey,
appreciated for its preservation properties,
but they also pollinate the flowers and therefore
increase the plentifulness of nature.
In Aphrodite's honeycomb temple at Mount Eryx,
the priestesses were the Melissae (the bees)
and the goddess was Melissa, the Queen Bee.
Aphrodite herself worshipped the bees
as her sacred creatures because of their
architectural capacities to create perfect hexagons.

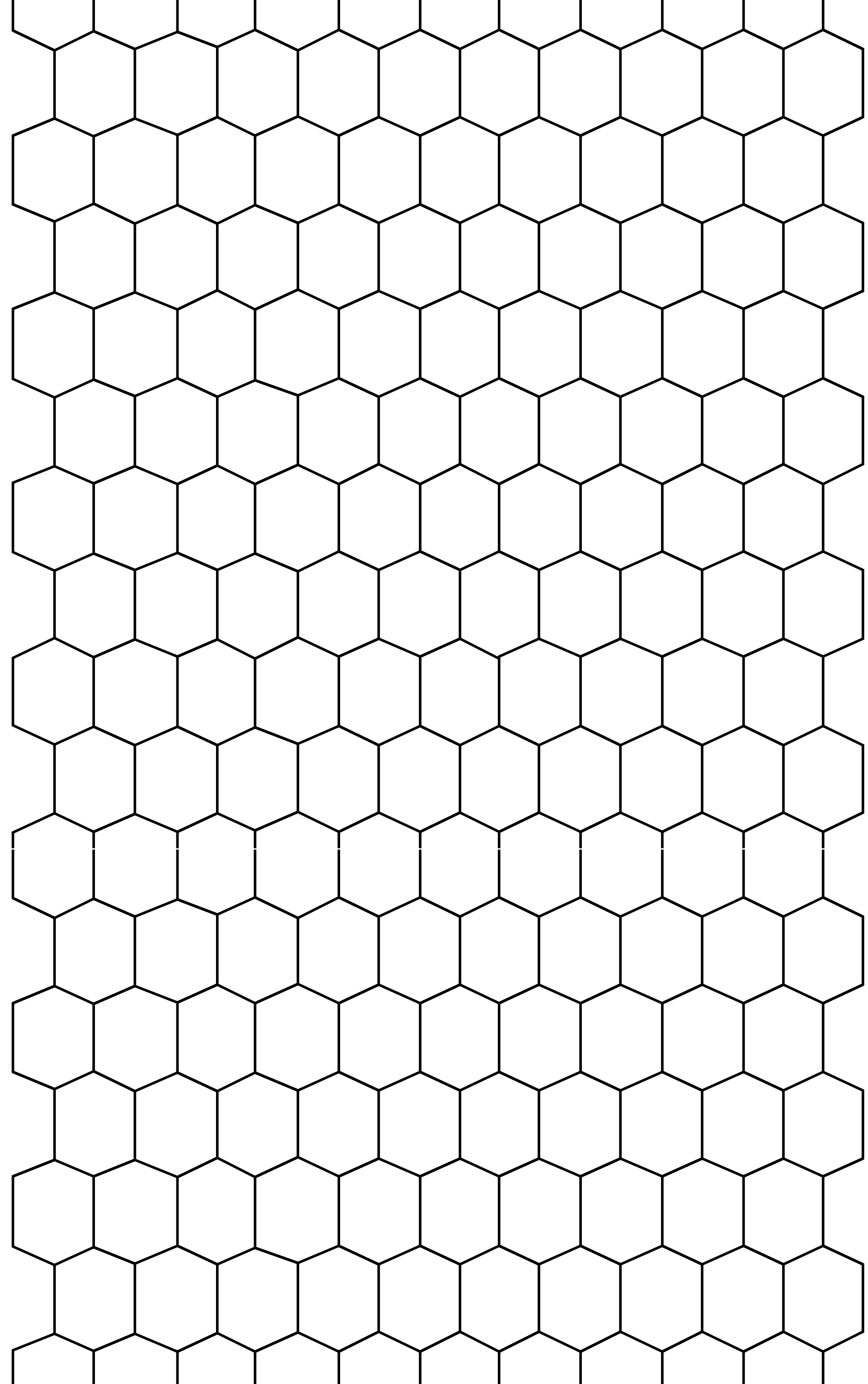


Fig.66
For the Pythagoreans the hexagon was an expression of the spirit of Aphrodite, whose sacred number was six. The Pythagoreans, trying to explain the secrets of nature through geometry, made drawings starting from the sixty-degree angles of the hexagon, and extending the sides of the hexagon to the center of the next hexagon cell. This results in an endless triangular grid and it was for the Pythagoreans a revelation of the underlying symmetry of the cosmos.

Fig.67
Working with bees requires a simple toolbox.
A strong claw hive tool and a soft brush are the basis.
The bees often secure the frames of the hive with propolis,
to protect their nest against wind and intruders of all kind.
Some power is needed to separate the frames.
Before closing the hive again, the soft brush is a good too
to sweep the bees gently inside.

Fig.68
Another tool that should not be missing are the gloves.
They are made from thick canvas and leather and prevent the bees to sting into the beekeeper's fingers when opening the hive for inspection.
The gloves are quickly stained with wax and propolis and they have their own specific apiary smell.

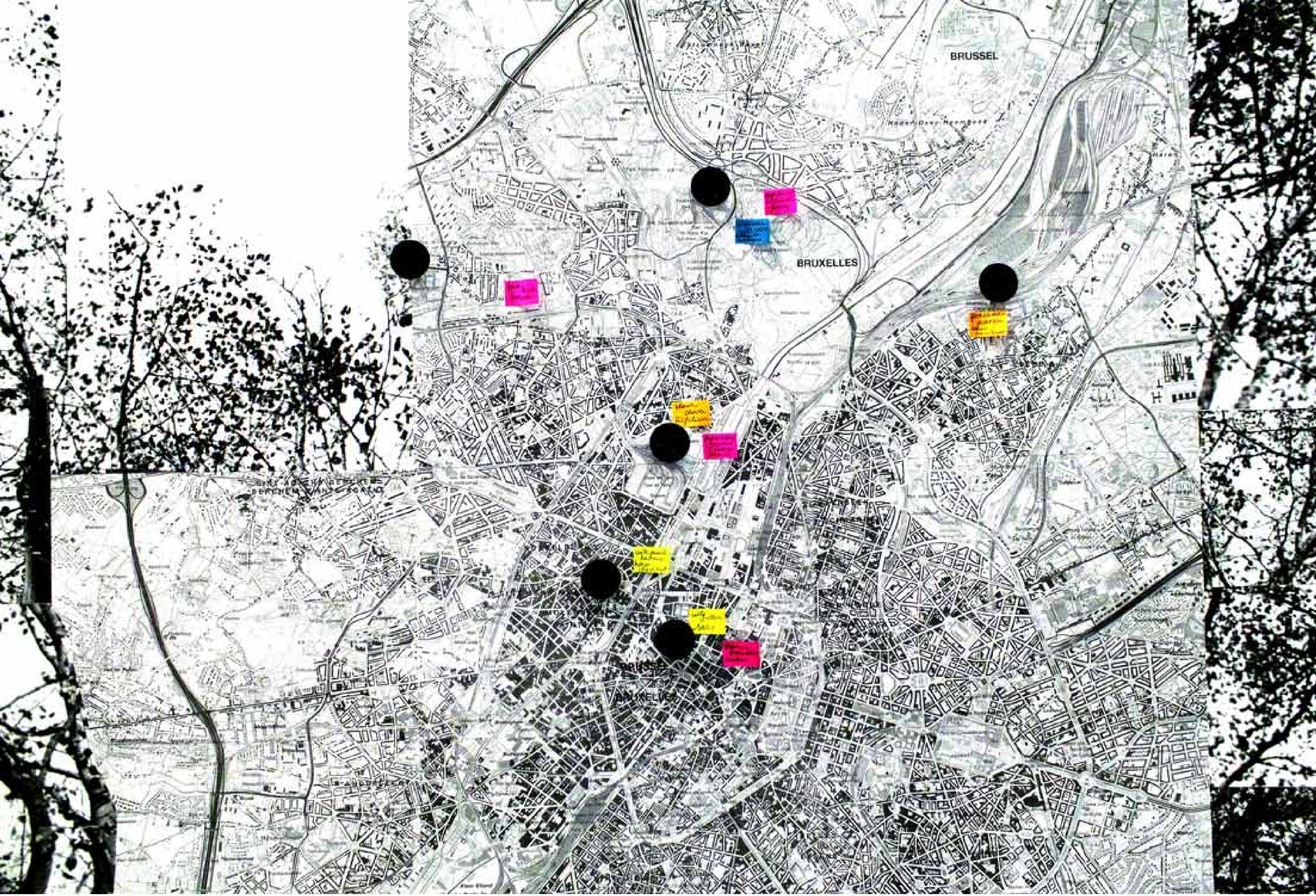


Fig.69 - The foraging areas of the honeybees are a fascinating research topic. Is it possible to reconstruct the bees' flight routes over the city and map out their food sources? Their fast take-off from the landing platform gives us only a vague indication of the direction they're flying to.

Fig.70
Pollution, pesticides, genetically modified crops and monocultures are, in combination with parasites and pathogens, contributing factors in the disappearance of the honeybees.
According to Albert Einstein, if all the bees disappeared of the surface of the globe then man would only have four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man.

Fact is that honeybee populations are declining around the world and so far there seems to be only one other way of pollinating mass numbers of plants.
It involves employing people to go round with feather dusters, brushing the insides of plants with pollen.
They are already doing it in parts of China to pollinate pear trees in areas where the insects are extinct.

Helianthus annuus tarahumara [sunflower] foraged by Apis mellifera carnica , august 2012, Brussels

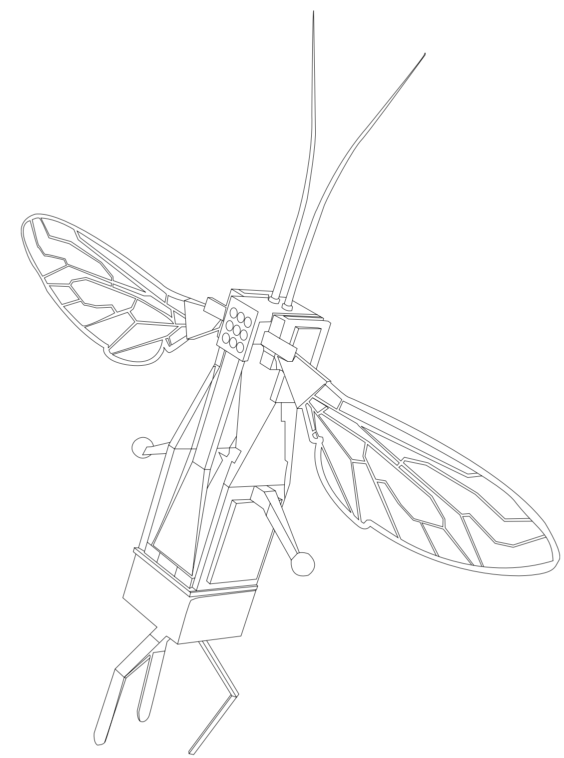


Fig.71
To save the world, scientists of Harvard University are developing the ideal robot honeybee, called the 'robobee'.
The researchers state that coordinated agile robotic insects can be used for 'a variety of purposes', including the autonomous pollination of a field of crops.

Fig.72
How can we study, measure, monitor, store and compare the differences between a biological corridor and the rest of the city?
What sustainable technology do we have to develop to monitor the changes in environmental urban layers?
We could work with Time Capsules, showing slices in time of a specific OpenGreen in the Corridor, represented by its environmental data.
Plant diversity, air pollution, soil quality and other abiotic elements as hours of rain and sun and wind.
But we should also include activity patterns representing the political, social, economical and historical layers.
Later we could analyse the data of different Time Capsules and study and compare the emergent patterns.

Pollen of the Heliantum annuus [sunflower], photographed with the SEM microscope.

Fig.73
The phyllotaxis, the patterns of leaf growth, of many of the plants point to the so-called Fibonacci sequence. The relation of the numbers in the sequence expresses the Golden Ratio proportions.
Several famous botanists studied in depth the importance of this kind of growth and forms in nature.

Computer generated Fibonacci sequence representing the head of a sunflower.

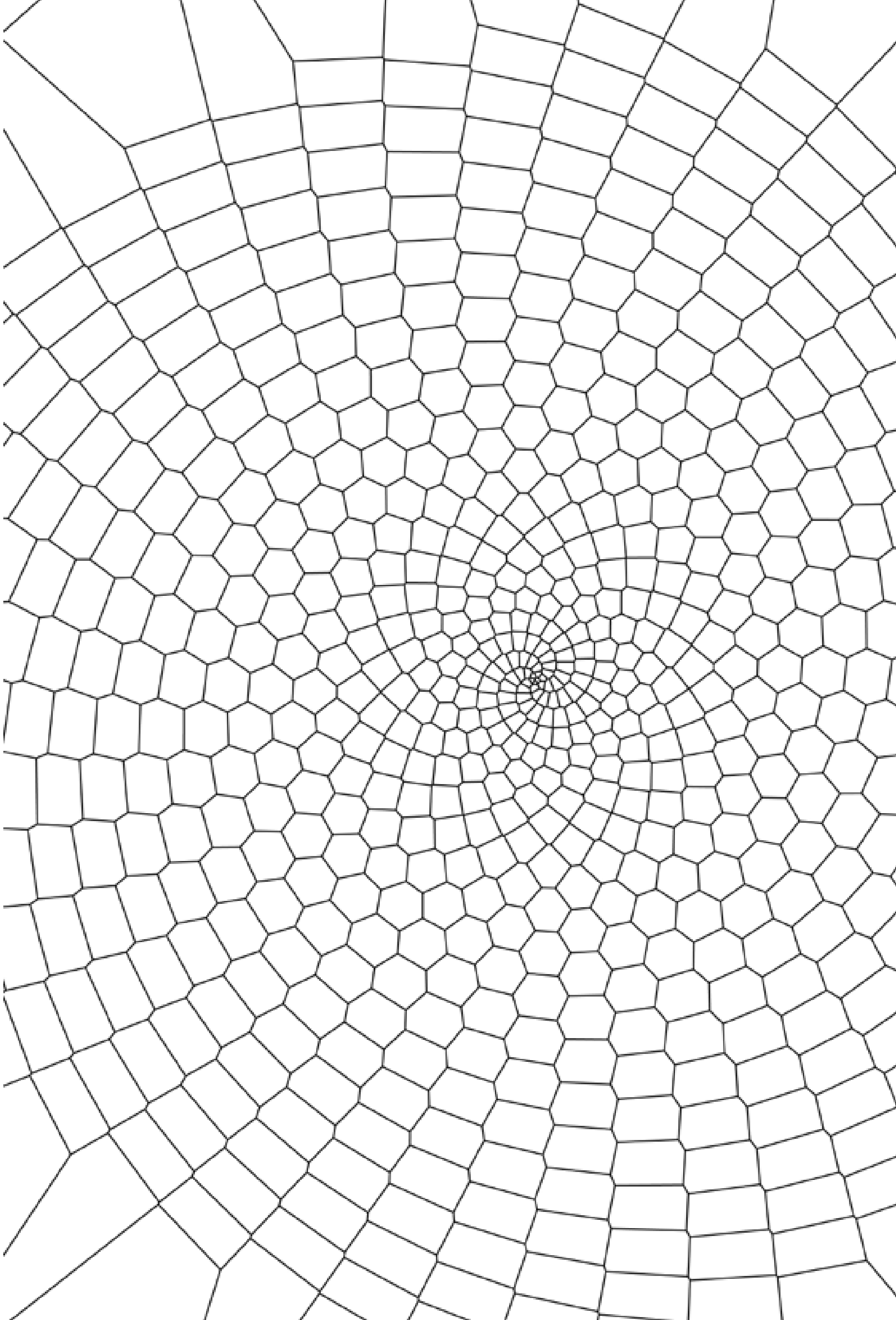


Fig.74
A cartography of the city's green zones in a
six-kilometre diameter around the hive is delineated.
Which honey plants and bee trees grow
in the parks and city gardens?
I organise bee-friendly botanical walks through
the city center to raise awareness about the plant diversity
in our urban ecosystem. Silent sound-walks along city avenues and
valuable edgelands offer an unexpected range
of wild herbs and flowers.
And, if necessary, the city is made greener
by acts of guerrilla gardening: vacant lots are bombed with
seedballs filled with a flower seed mix for pollinating insects.

Helianthus annuus giganteus [giant sunflower], foraged
by the bees of hive 1 and 3, summer 2012.

Fig.75
The next step in the development of the bee-walks is to create enhanced spectacles, a head-mounted frame with ophthalmic lenses ranging in the bee-spectrum of colors (ultraviolet but no red) so as to discover the biotic components of our cities through the faceted eyes of a honeybee.

Bee eye, x295 - SEM microscope.

Fig.76
Honeybees are a good bio-indicators.
Biological indicators are species that are used to monitor the health of their ecosystem.
Bioindicators can tell us about the cumulative effects of different pollutants in the ecosystem.
The honeybees are generally doing well in the city.
City honeybees have more food diversity, and less problems with pesticides and monocultures.

Fruit of the Erodium cicutarium subsp. dunense [Common Stork's-bill, Geraniaceae]

Fig.77
Sometimes we need a fast and handy tool to monitor the colony without opening the hives.
The spools that I found in an abandoned textile factory in the north of Italy, are perfect for accomplishing the job.
Put the one side to the outside of the hive's broodbox, and the other side at your ear.
Give a short but loud clap on the broodbox.
The bees should answer with a swelling zoom that fades away after one to three seconds.
This is the sign that the colony is OK.

Fig.78
From a German friend I get this strange object:
'Tester for determining repositories and
foraging sources of your honeybees'.
It is an invention by a Dutch engineer and asks for a very
detailed and complicated step by step execution,
considering geolocation, position of the sun,
bee dance information and time tables.
I never managed to get satisfying results
with this complicated device.

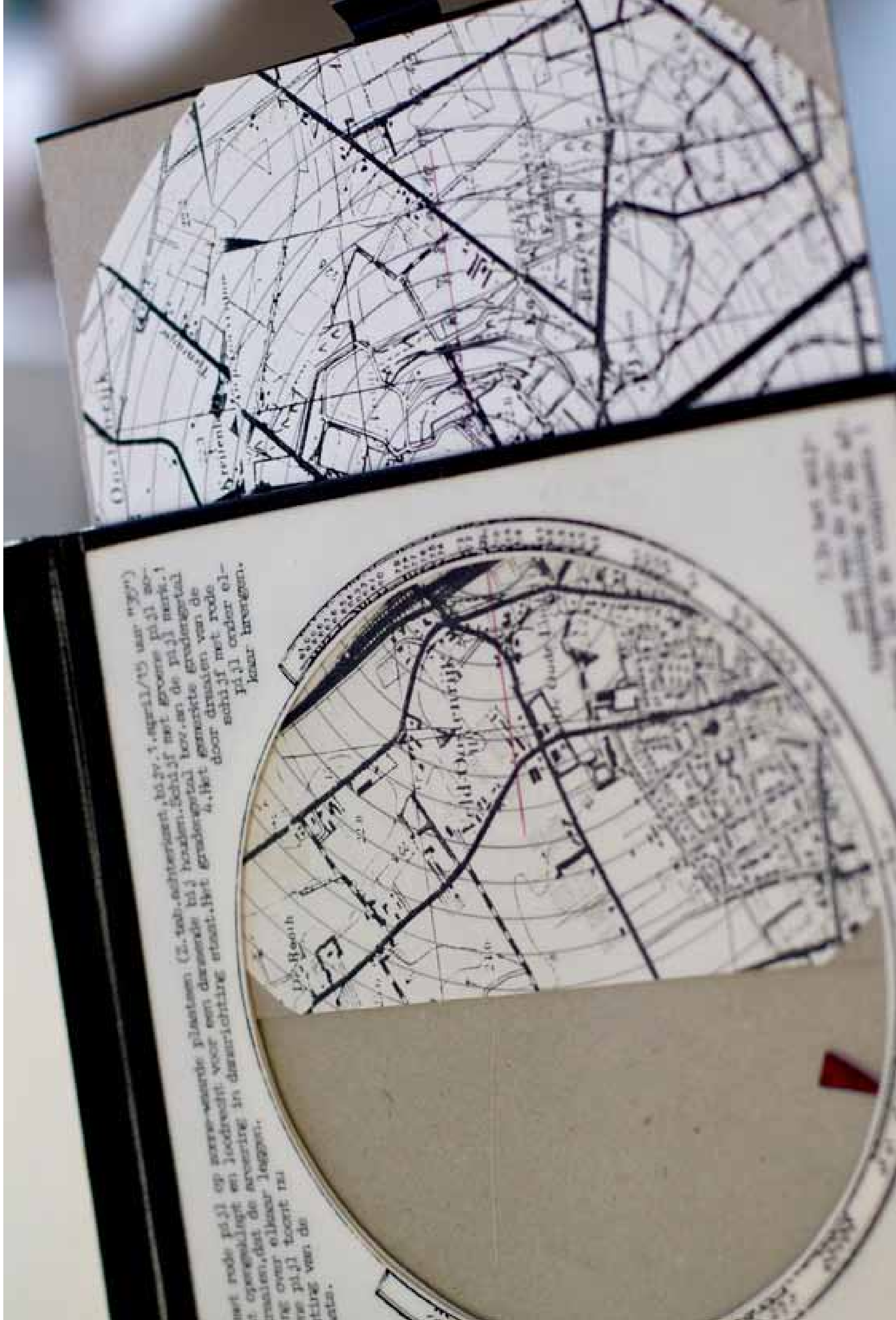
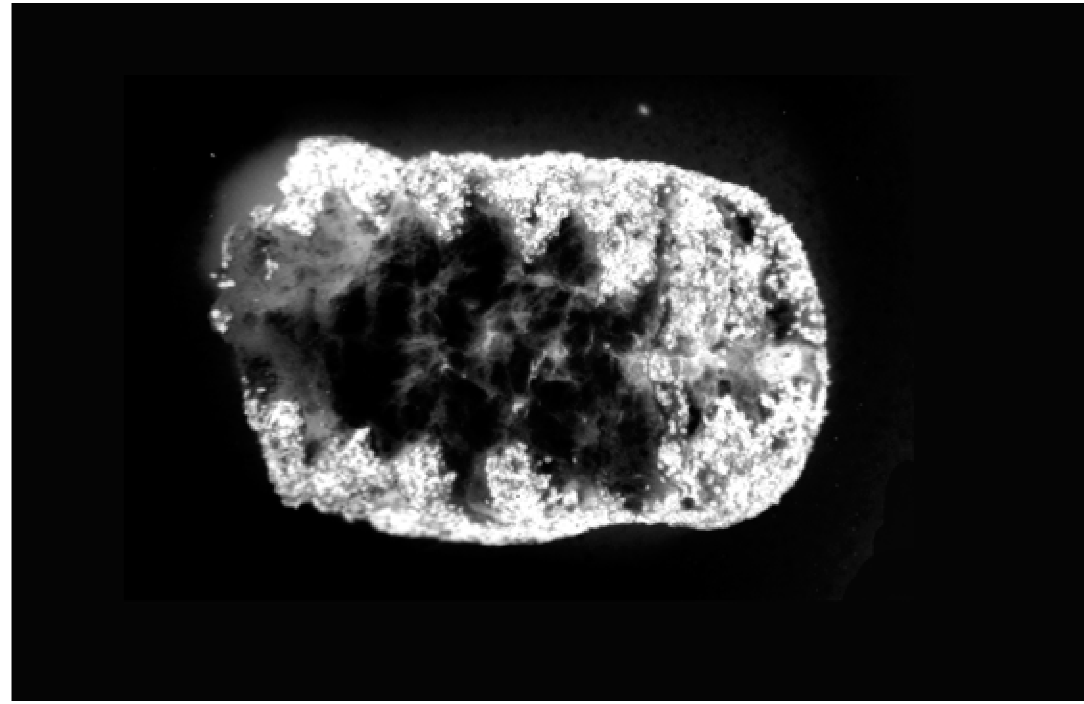


Fig.79
I participate with the bees of hives one and two in a scientific research project of the University of Ghent. From the researchers I got 2 plastic bags, 2 plastic boxes and 2 sheets of white paper. From two hives I had to catch 25 bees at each of the landing platforms and put them in the plastic bags. they were placed for one night in the freezer where they died -immediately- for the sake of science. The next day, I transfered them to the plastic boxes and labelled them with my number. The white sheet of paper -the diaper- was placed for a day on the varroa drawer of the hive. I registered the amount of fallen mites and this information was send with the dead bees to the university.

Fig.80
The Bee Doc Project comprises a network of eleven partners from honeybee pathology, chemistry, genetics and apicultural extension aiming to improve colony health of honeybees. The Bee Doc Project will empirically and experimentally fill knowledge gaps in honeybee pests and diseases, including the 'colony collapse disorder' and quantify the impact of interactions between parasites, pathogens and pesticides on honeybee mortality.

Fig.81
Colony collapse disorder [CCD] is a phenomenon in which worker bees from a beehive or European honey bee colony abruptly disappear. The cause or causes of the syndrome are not yet fully understood, although many authorities attribute the problem to biotic factors such as Varroa mites and other insect diseases. Other possible causes include environmental change-related stresses, malnutrition and pesticides [e.g. neonicotinoids such as imidacloprid], and migratory beekeeping.
More speculative possibilities have included both cell phone radiation and genetically modified crops with pest control characteristics.



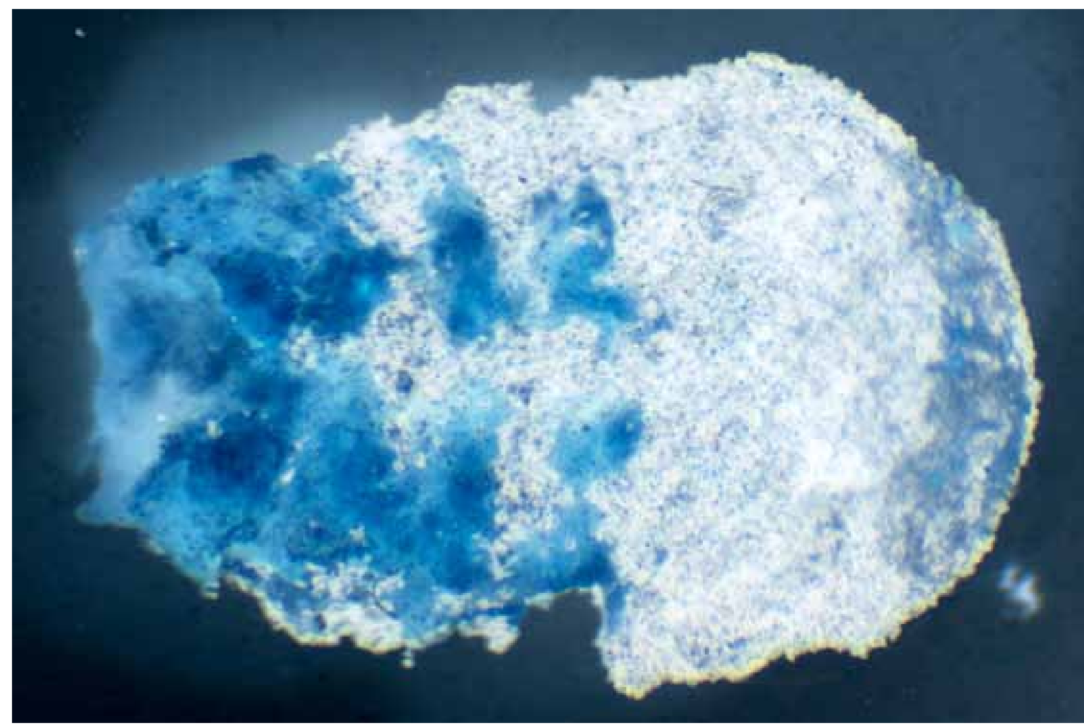


Fig.82
After the winter I discovered chalkbrood in one part of the hives. The bees were cleaning out the infected cells and deposited the petrified bee-pupae on the landing platform. A colleague beekeeper told me that, once the temperatures rise again, the chalkbrood disappears by itself if the general health of the colony is ok.

The bees from hive3 (previous page, and at the right) suffered from chalkbrood, but today the colony is completely healty again.

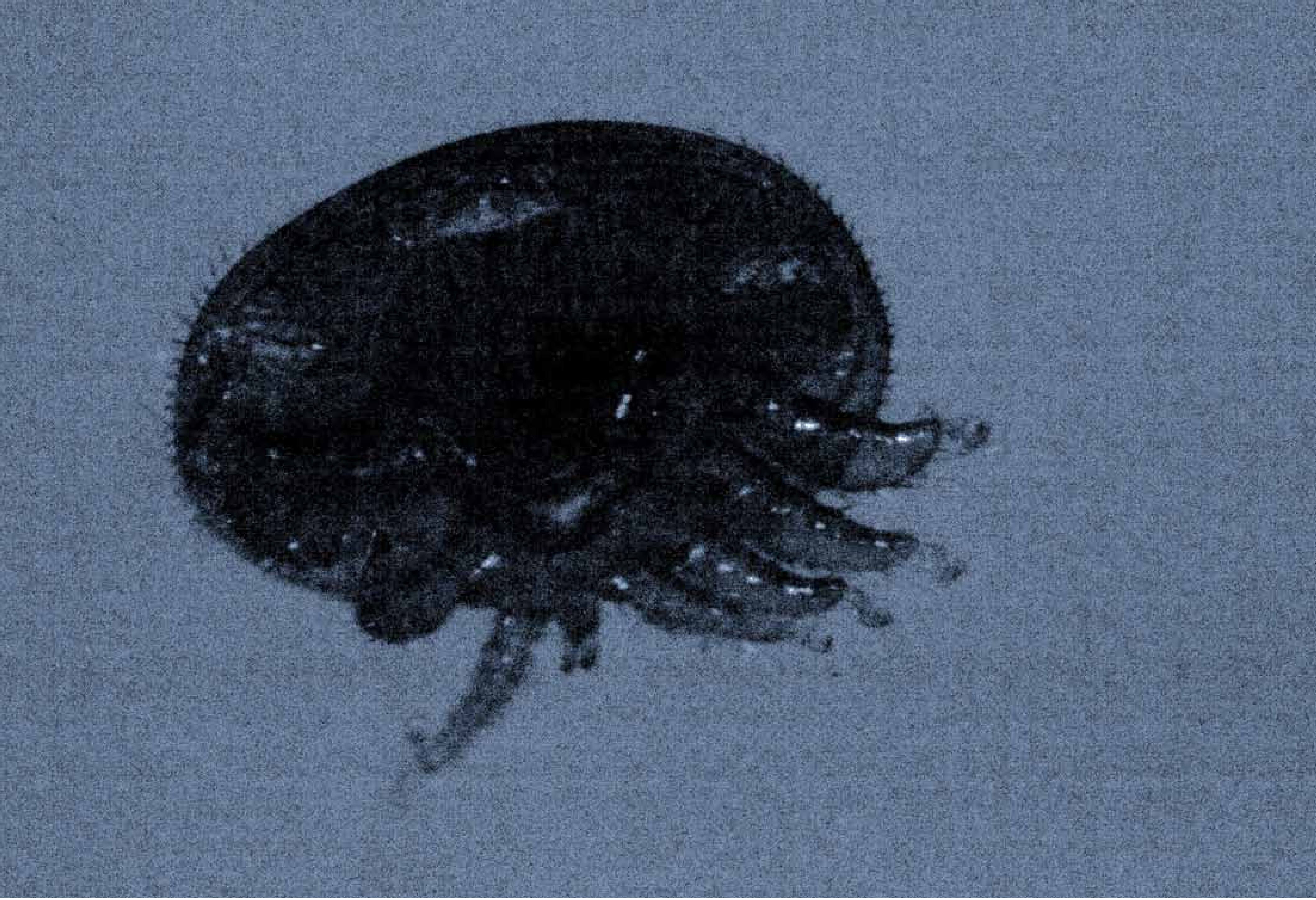


Fig.83 - A varroa mite photographed with the stereo microscope. The specimen is magnified x 70. The varroa mite slips into the cells when the larvae go into the popping phase. They suck the lymphal fluids from the puppae and thus they weaken the puppae in their development to an imago. The young bees infected by the varroa parasite become less resilient to other diseases.

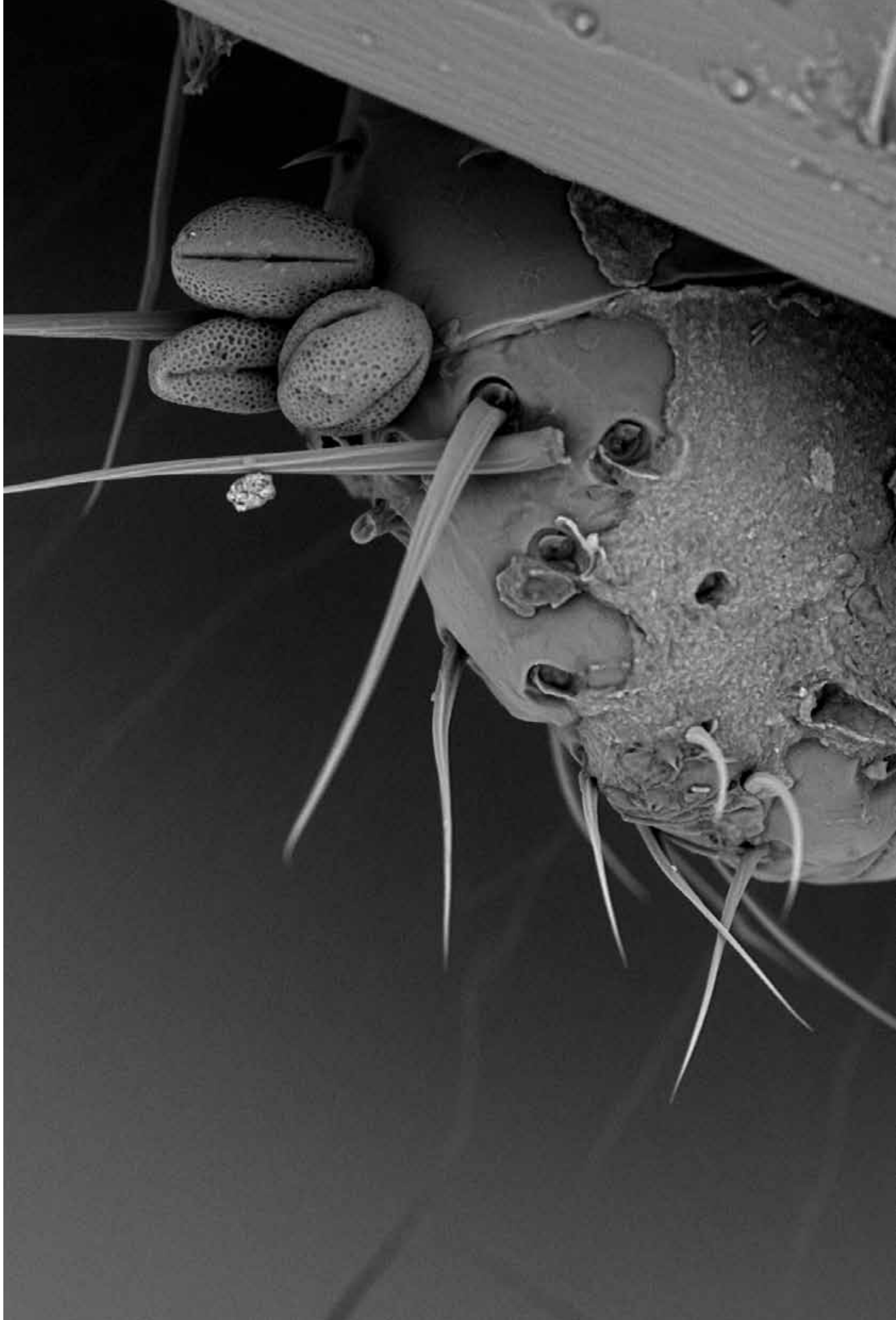


Fig.84
One of the legs of a varroa mite, photographed with the SEM microscope and magnified x 930.
Even a varroa parasite transports pollen.
The pollen were probably transfered to the mite's legs when she travelled inside of the beehive upon the body of a forager bee, to disappear into a cell with a larvae.

Fig.85
Test tubes filled with wax and a solution of shellac resin, used for fixing and protecting the electric wires of the sensors and thermistors on the frames.

Fig.86
The comb consists of connected cells with the form of regular hexagonal prisms. The utilization of space and building material is optimized by the hexagonal construction.
One edge of the hexagonal prism points to the top, and another to the ground. The geometry of the shape and depth of the cell bottoms and the manner in which they dovetail into each other contributes a great deal to the stability of the comb.

There are architectural models that are made after biomimesis of hexagonal honeycomb cells.
Many architects are inspired by the bee comb.
The Japanese Metabolist Architecture movement in the 1960s developed an architecture and urbanism that acted as a critique of both society and the construction industry.
The dwelling unit was considered a repeated and irreducible unit.
It minimized private space and was plugged into an infrastructural megastructure that could grow or adapt.

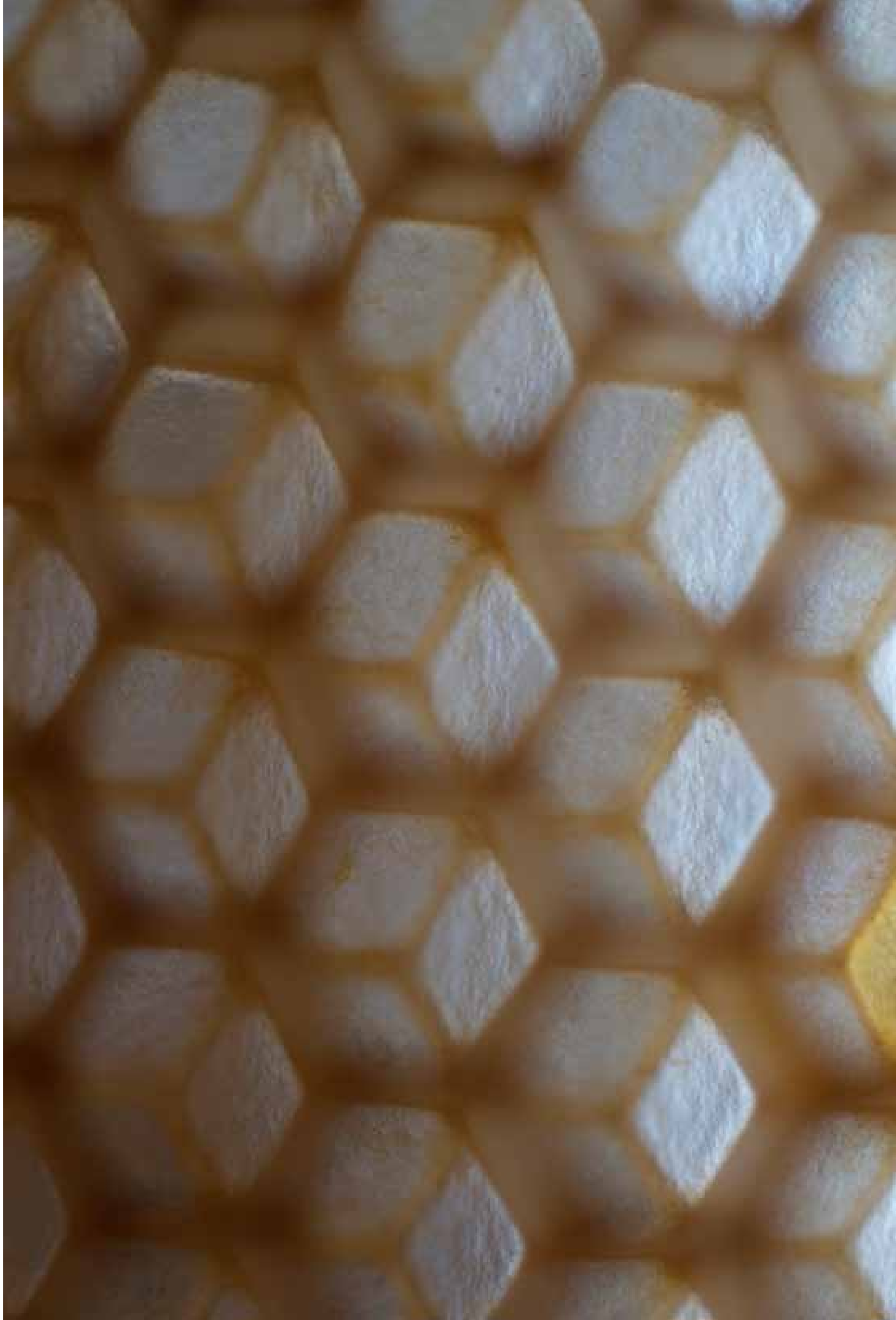


Fig.87
This is a real virgin beeswax structure.
The bees measure the thickness of the cellwalls with their sense organs on the tips of their antennae.
Building can proceed quite rapidly, the best builders are the young bees in the swarms. When the bees start building from scratch, they first attach themselves to each other in chains.
The orientation of the comb-building is influenced by the magnetic field of the earth.
That's why so many bees can build together at one piece of comb and still deliver a perfect metrical result.

Fig.88
My horror was immense when I discovered one morning late april pops of the the beekeeper's ennemy -The Waxmoth- under the felt cover of the Transparent Beehive.
The bee colony of the Transparent Hive became impaired through winter, and than there was the bad weather in spring.
This was enough for the moths to attack.
They found cosy and warm spots to settle and lay their eggs without the bees resisting too much.
And so come that, after an absence of mine of two weeks, I was confronted with a destructed hive when I came back.

Fig.89
The greater wax moth [Galleria mellonella] can hear sounds of a higher frequency than any bat can produce.
Even though its ears are extremely simple — a pair of eardrums on its flanks that each vibrate four receptor cells — it can sense frequencies up to 300 kilohertz, well beyond the range of any other animal.
Its larvae, the waxworms, feed on the honeycomb inside bee nests.

Wax moth, strereoscope x 30.

Fig.90
This was the situation confronting me when I took off the felt from the plexiglass cube.
The destruction was total, all bees where gone.
The once so proud and solid bee architecture has collapsed to crumbles.
The rests of the stored honey dripped out of the hive.

This is the end of the Transparent Beehive project (for now).
I start emptying the hive and rescue what is left from the wax structures.
I take all sections apart and clean them thouroughly with soap water and desinfect them with bleach.
I have already improvements in mind for a second version of the experiment.

Fig.91
I melted the recuperated pieces of wax comb and filtered them several times.
This is what the bees left me, I see it as a gift and a reminder to be more careful with nature and natural resources as honey bees. We need them.

4. objects

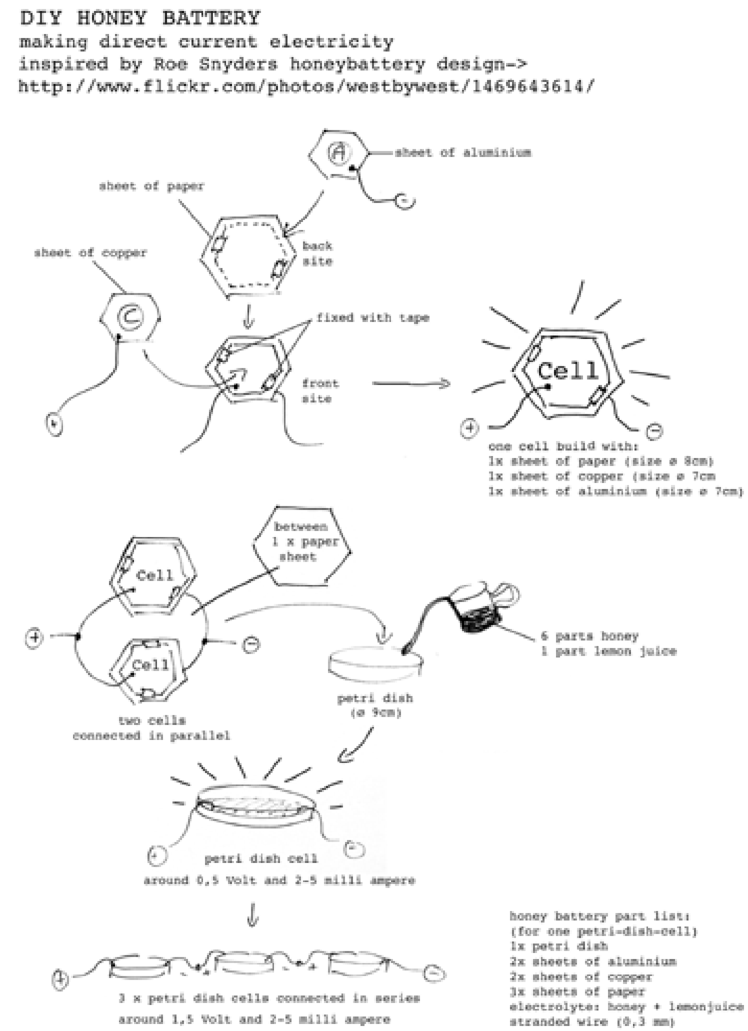


Fig.92
In a workshop that I organised with Ralf Schreiber
I started to investigate the use of bee products
as wax, propolis and honey, for alternative purposes,
in particular batteries.
We cut old beeswax out of the frames and
melted the comb in a pot on the BBQ.
After filtering the liquid from dirt and
popping rests from the larvae we ended up
with a nice substance to start working
with the battteries.

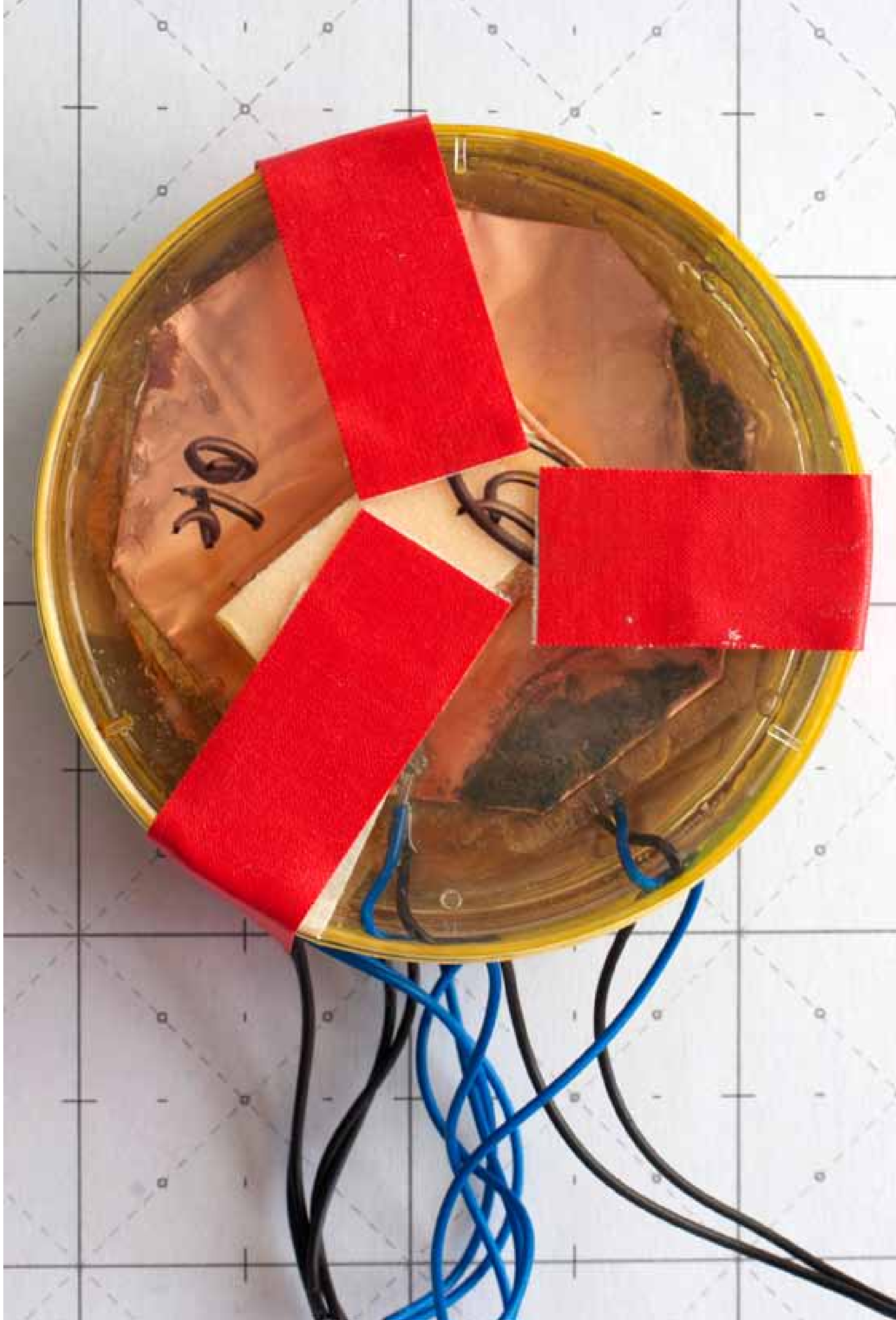


Fig.93
The small honey batteries work like galvanic cells. Honeyis a bit acid, and using a very thin sheet of copper and a thin sheet of aluminium, the acid from the honey starts to produce electricity.
One petridish battery produces half a watt and linked in series of 3 they produce 1,5 - enough to power the OpenGreens garden robots.

Fig.94
The robots are dipped in the melted beeswax.
The idea to dip them in the liquid wax was developed while working with the bees.
It's a nice way to make the robots safer for humidity or rain when they are operating outside.
The robots become also more organic.
The one at the right walks autonomously when its stepper motor is connected to the honey batteries.
I call it the Una Bomber.

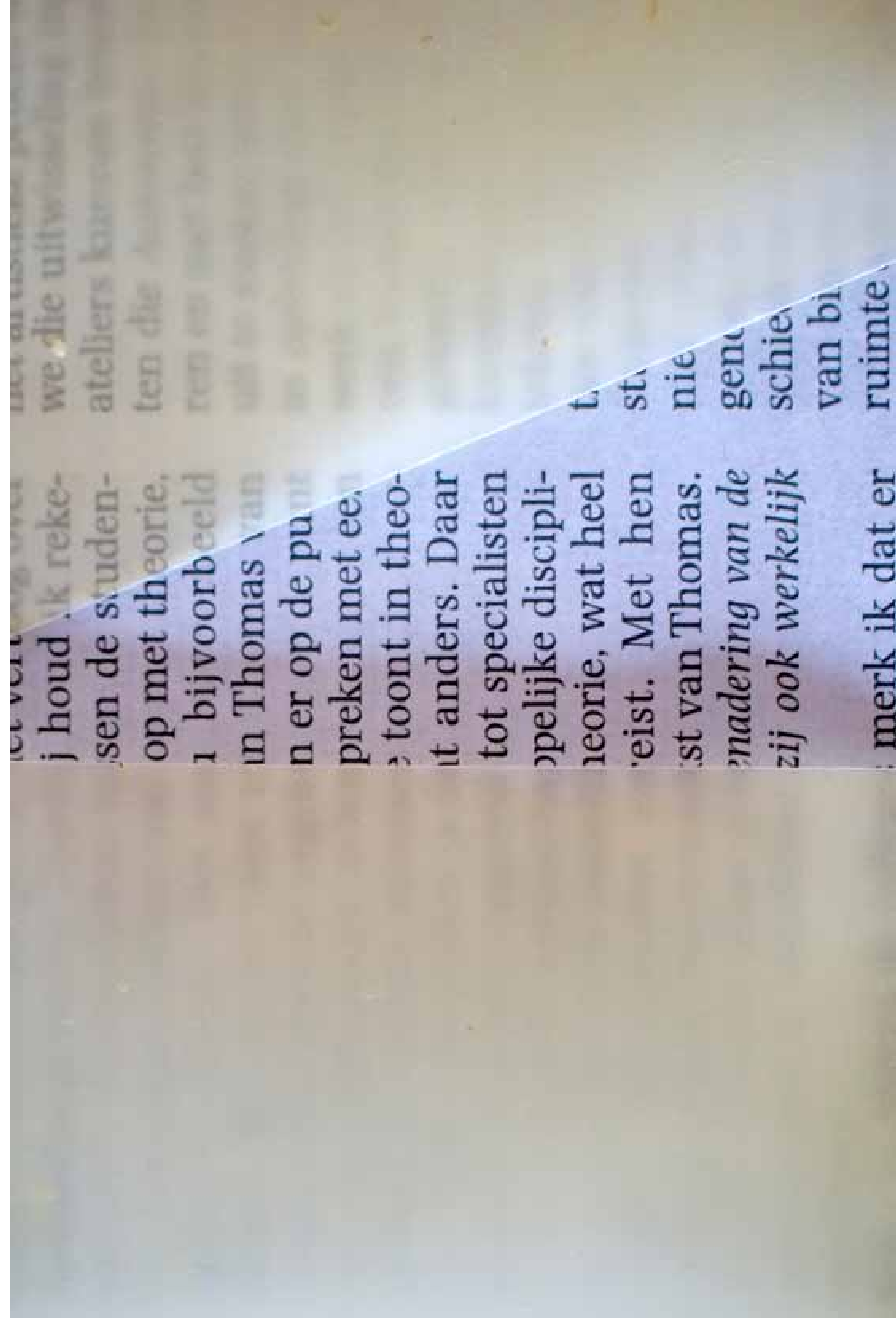


Fig. 95
Tracing paper dipped in bleached beeswax derived from the honeycomb of the Transparent Beehive.
The wax' melting point is around 60°C.
Wax is insoluble in water but can be dissolved with alcohol and when it is heated above 85°C the color changes and discoloration takes place.
This bleaching proces is mostly applied for wax used in cosmetics and pharmaceuticals.

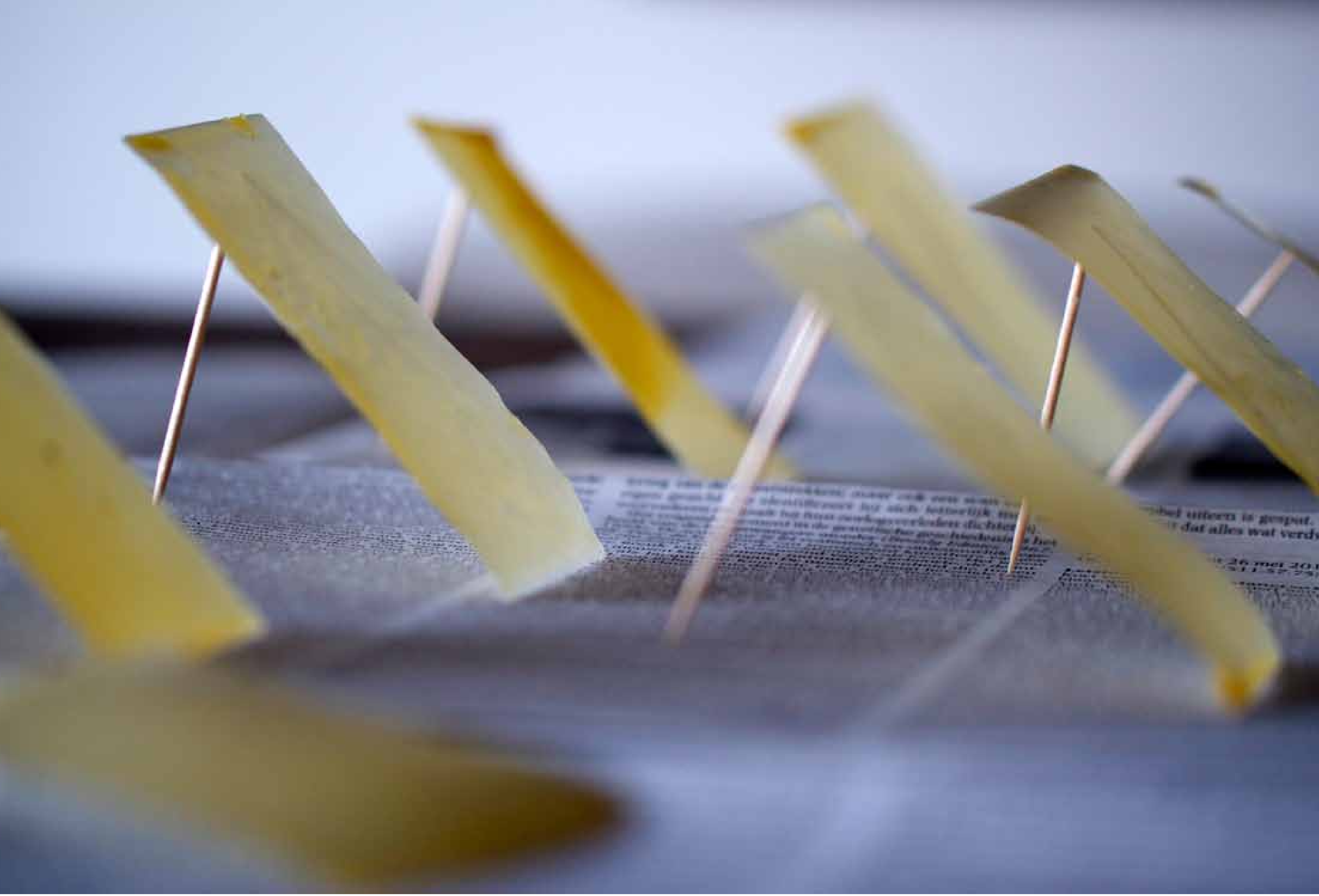


Fig.96 - Lightness and gravity are the decisive factors in this experiment with wax, tracing paper, newspaper an tooth pics. The image is like the domino effect or chain reaction.

Fig.97
Mouth sealed with a samara, the fruit of the Acer pseudoplatanus [Sycamore maple] dipped in wax.

Fig.98
The yellow dot.
An aesthetical perception of pollen accumulations,
a simple question of beauty
a perfect mix of culture and nature.

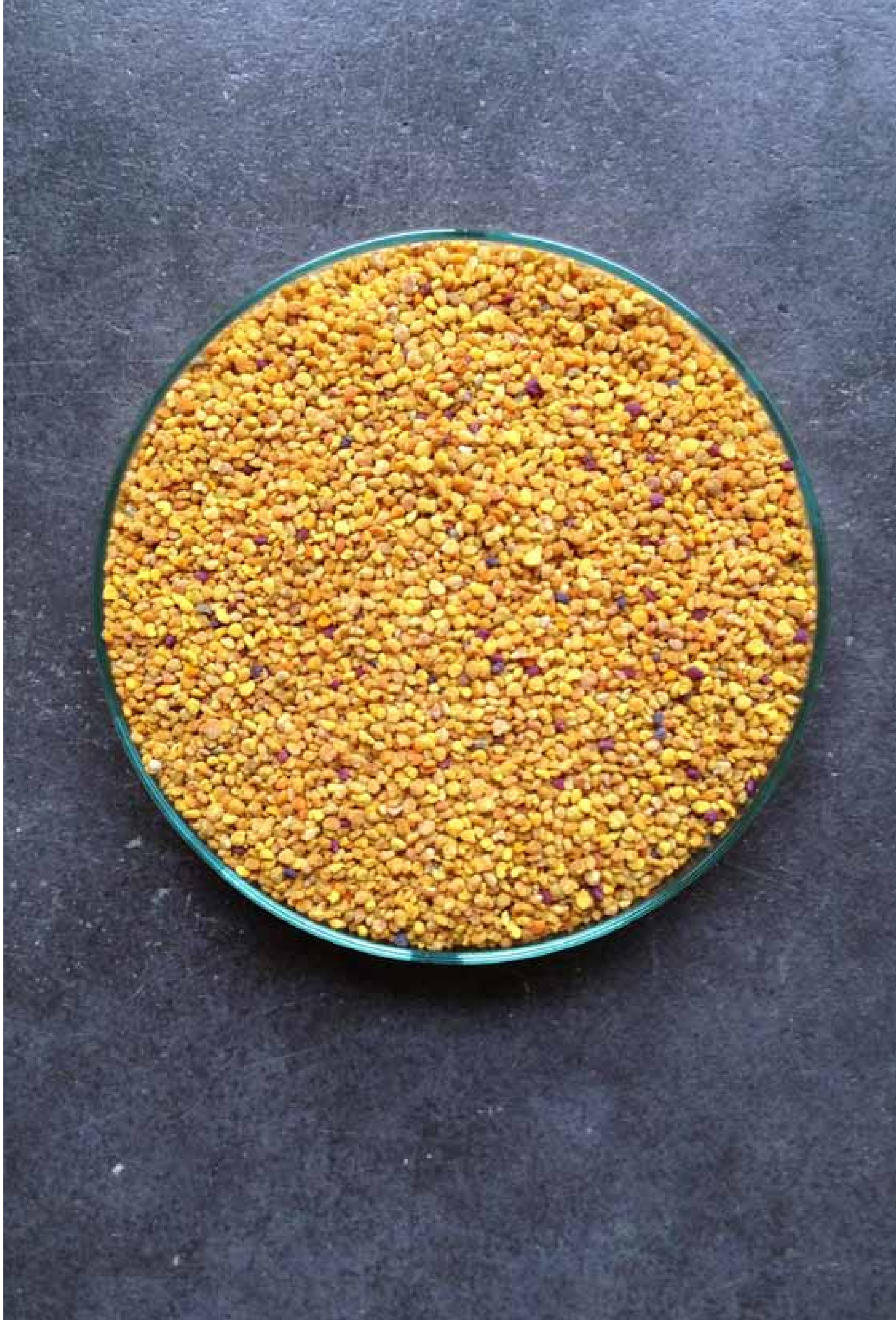


Fig.99
A substance preserves its internal logic even when it participates in this process of transformation.

Fig.100
The stick, ritual performances.
The origin of honey is feminine.
The beehive is a matriarchal society.

Seedpods [drumsticks] of the Moringa oleifera tree dipped in beeswax.

Fig.101
The colour of wax varies from nearly white -for freshly constructed comb-, to brownish - for the brood comb - which shades darker because of the mutating rests from the puppae. Most often the colour of the comb is perceived in different tints of yellow, while processed and cleaned wax turns bright orange.

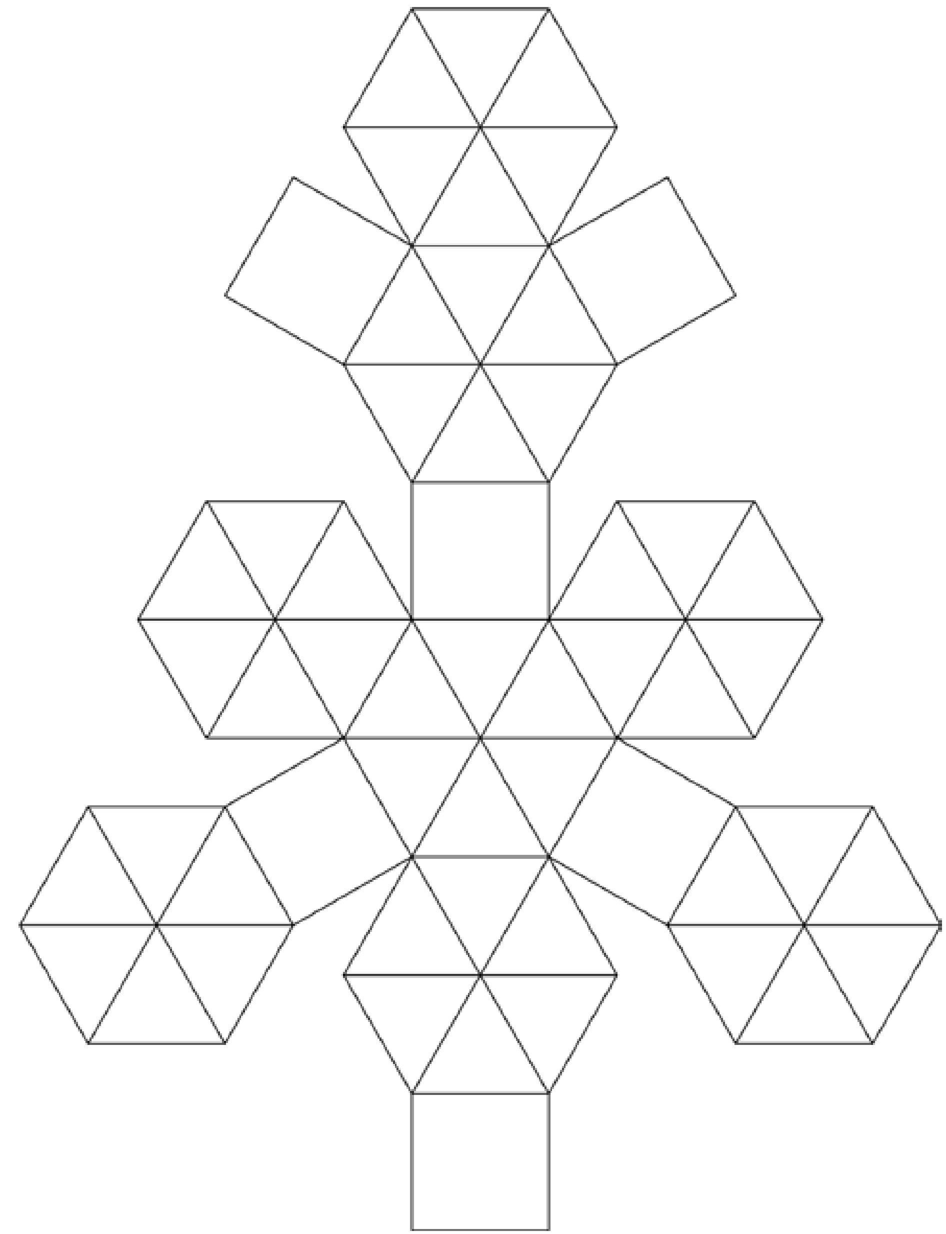


Fig.102
In nature, hexagonal patterns are very common due to their efficiency.
In a hexagonal grid each line is as short as it can possibly be if a large area is to be filled with the fewest number of hexagons.
This means that honeycombs require less wax to construct and gain lots of strength under compression.

In this experiment we draw plans for creating truncated octahedrons which we will use as models for bee appartments.

Fig.103
The truncated octahedrons are realised in foamboard.
They are placed in the hive to study if the bees will integrate them in their nest.
The experiment was not succesful, the bees were gnawing on the paper but did not construct anything around the octagonal volumes.
The mistake was to place the unnatural objects into the honey super instead of the broodbox.
Better had been to insert them in a completely empty hive filled by a fresh swarm.
This idea needs a follow up in a future experiment.

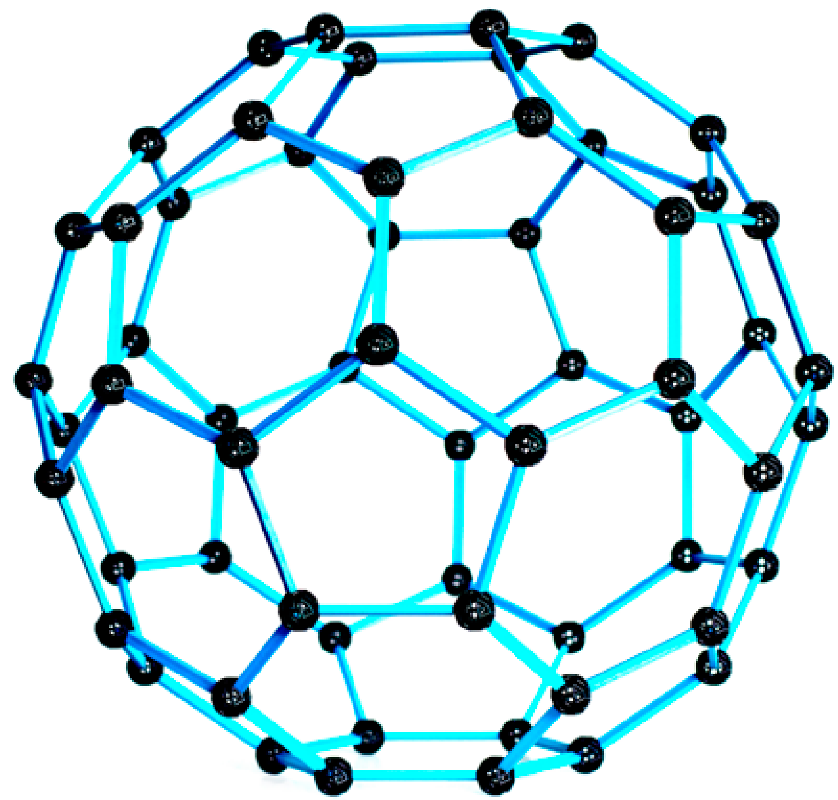


Fig.104
There are plenty of references to honeycomb in the work
of the visionary architect Buckminster Fuller.
Fuller popularised the geodesic dome which is, similar to honeycomb,
based upon lightweight structures that are
super strong due to continuous tension on the triangular
pentagonal and hexagonal planes.
Fuller also gave his name to the Buckminsterfullerene,
a molecule composed entirely of carbon,
in the form of a hollow sphere.
The molecule is also called a buckyball.

Fig.105
I am working together with my bees to
create natural sculptures.
In the fablab I collected some intresting
found material which I adapted to the needs
of the bees and the hives.
I have inserted two adjusted frames in
one of my 'split-off' colonies from this year.
Very quickly the bees start to build their own additions,
creating a remarkable amalgam.

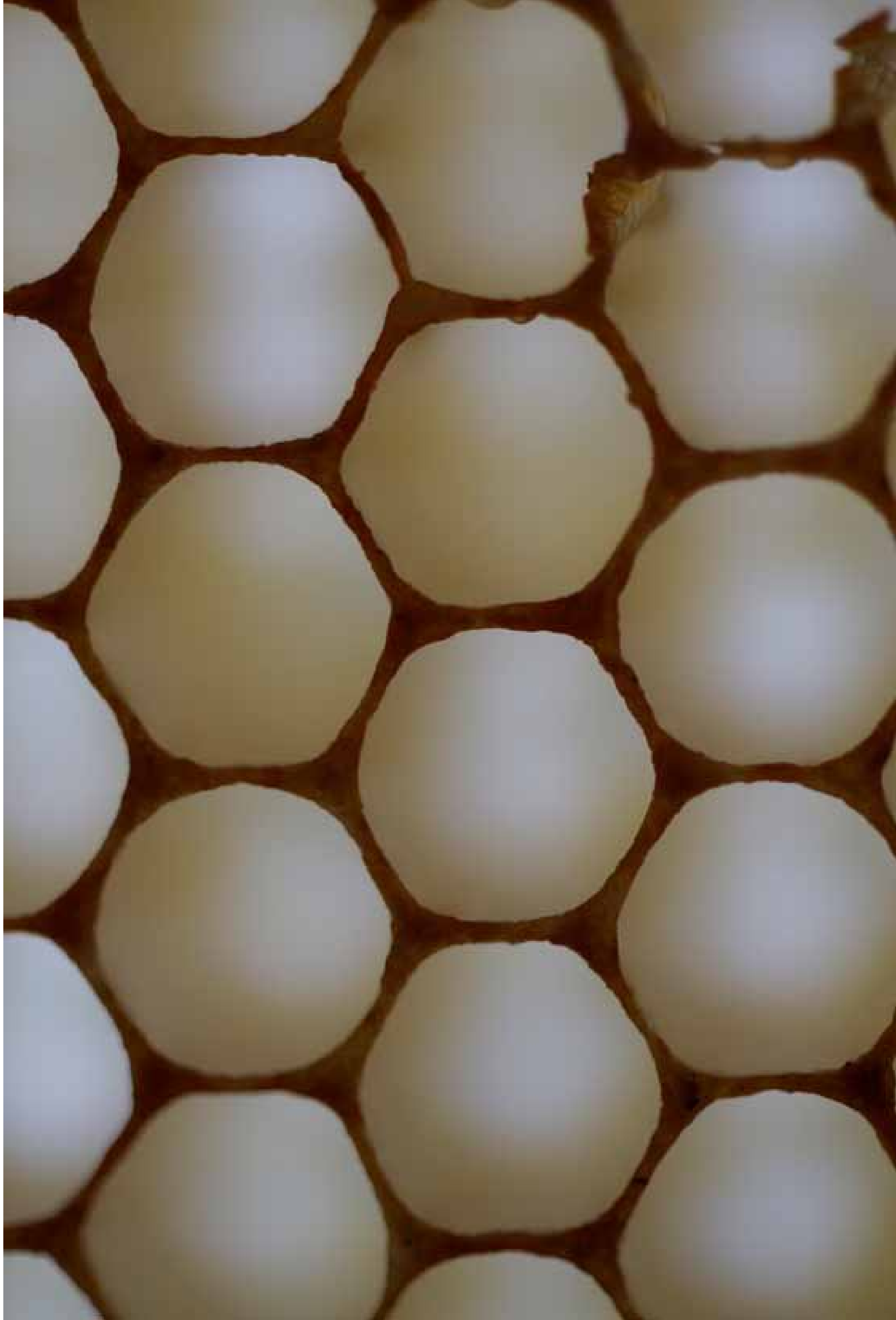


Fig.106
Cells.
Each of them can accommodate one bee (ing).
The bees' body is the basic template for
the construction of a cell.
From a cylindrical form the cells become hexagonal
under the tension of the regularly constructed comb
and heated by the bees' bodyheath.
In these cells transformation takes place.
Similarities with hermitages, retreats or
monasteries are not far away.

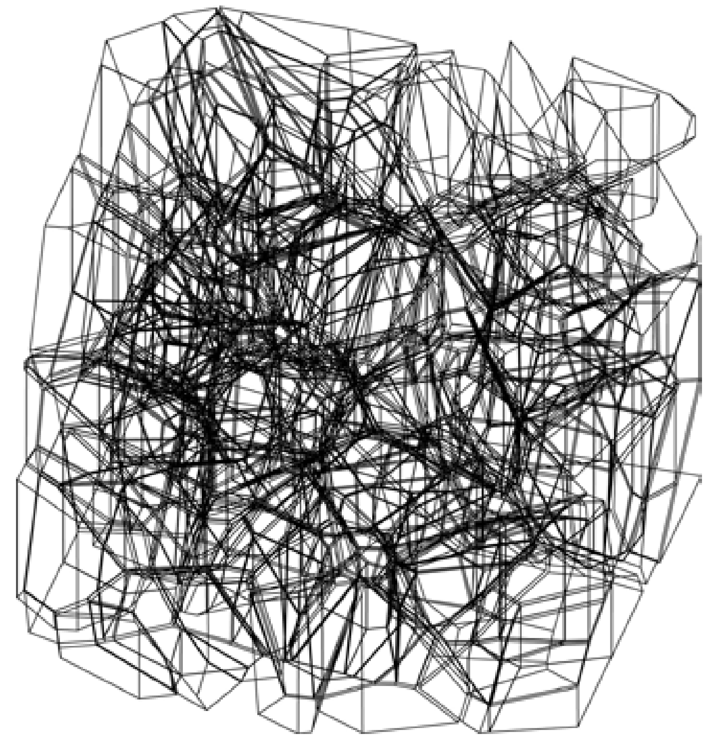


Fig.107
Chaos in the beehive.
Rendering of irregular cells and bubbles, a representation in 3 dimensions by the Voronoi algorithm.

Fig.108
The german biologist Ernst Haeckel produced finely detailed drawings of radiolarians, a group of unicellular organisms found as plankton throughout the oceans.
These magnificent examples out of nature are a source of inspiration for the design of organic beehives.

Fig.109
The hive is a system of homeostasis.
Homeostasis is the property of a system that regulates its internal environment and tends to maintain a stable, constant condition of properties like temperature or pH.
It can be either an open or closed system.
A medium sized nest needs 1200gr wax to be build, and 7,5 kg honey for the energy.
Beeswax is composed of more than 300 different chemical components.

Fig.110
After visiting the Koç University in Istanbul february 2013,
I start thinking about links between haptic robotics research,
neuroscience and the antenna's of insects.
Receptors, senders and receivers, input and output (but what is happening inbetween?).
Stings, pheromones, poison, skin, reactions, multifaceted panoramic vision eyes, antennae with 3000 receptors, electrically charged fur for pollination purposes: examples of high tech nature and high technology.

Fig.111
For new hive designs, we have to think about new materials, inspired by nature.
We can experiment with a list of raw materials as corn starch, brown sugar, glutinous rice, coconut fibers, hemp, linen, flaxfibers and cotton and ofcourse propolis or other organic glues.
We can cut old natural woven carpets with the lasercutter.
We can dye raw materials with color extracts from plants as indigo from the Indigofera tinctoria or orange from the Calendula officinalis.
I started a nursery of dye plants to set up new experiments.

The design at the right is inspired on the natural form of a swarm and realised with plantfibers from sunflowers and Calendula officinalis, a mix of dried herbs and seeds, and recycled paper.

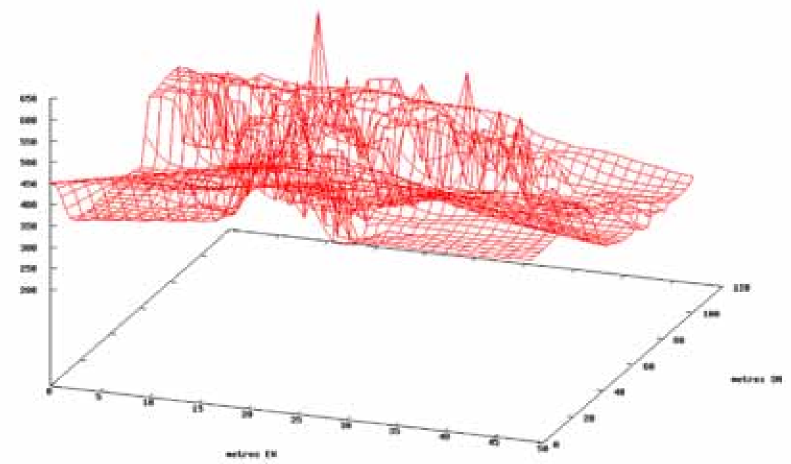


Fig.112

Electromagnetic fields can have adverse effects on living organisms, and honey bees are especially sensitive to it.
Although urban environments provide beneficial habitats for bee colonies, the electromagnetic field concentrations can disturb the bees' orientation and communication capabilities.
I follow a workshop with Martin Howse, invited by Foam. Participants make their own DIY-devices for measuring electro-magnetic fields. To assist city bees with the EMF-issue, we work on an interference free foraging map. As a test we organize an EMF mapping walk in the okno rooftop garden. [There is a Mobistar antenna right above our heads]. This is a visualization of the data gathered during the walk with 5 walkers and 5 devices. Again we have to ascertain wide band high frequency intensity.

Martin Howse - http://www.psychogeophysics.org

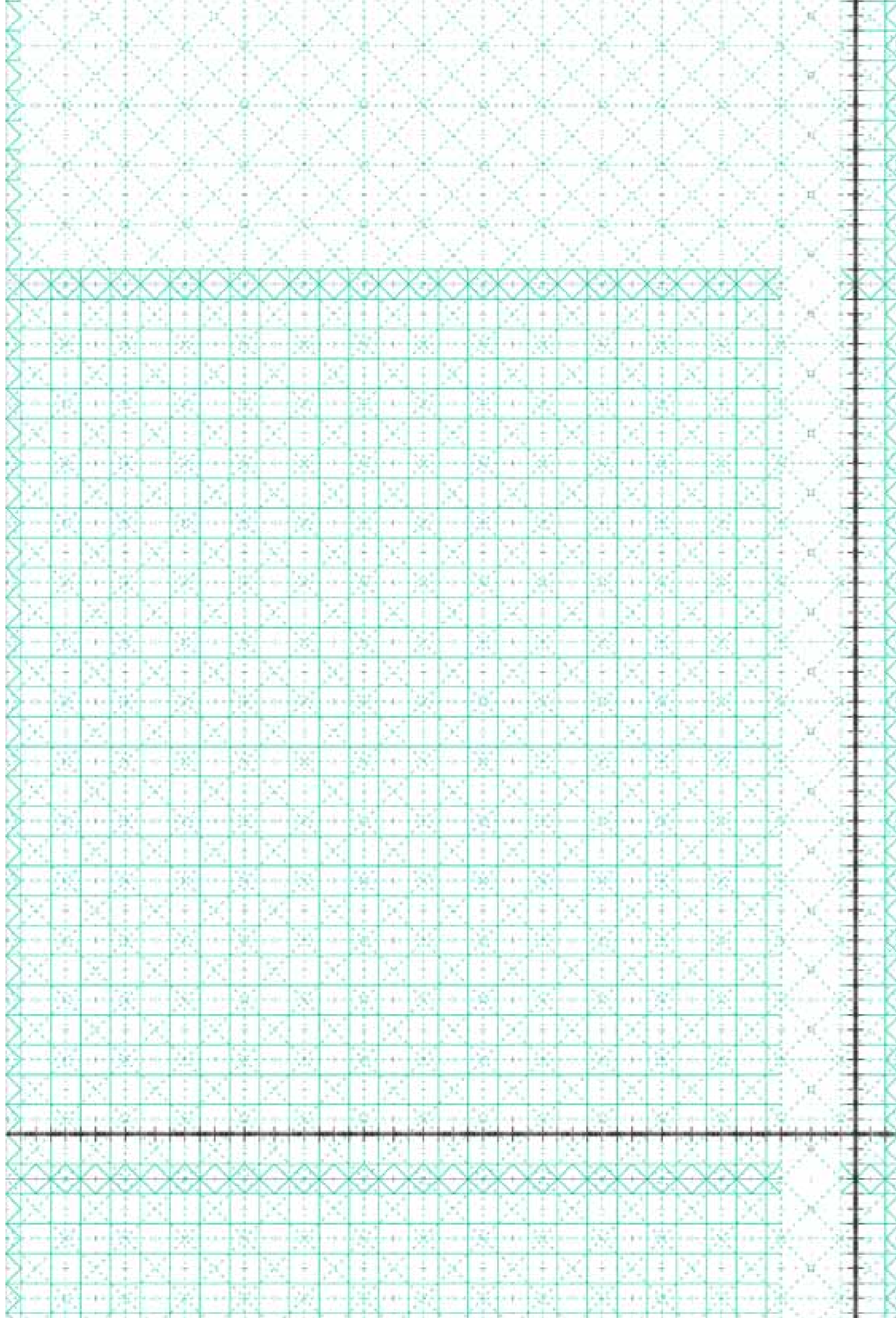


Fig.113
The Transparent Beehive is designed along the principles of the OpenStructures grid.
All OpenStructures should be conceived as interdependent, dynamic puzzles. This means that they should be designed for disassembly and according to the same dimensional framework.
To facilitate the design- and building process of open modular objects, an OS-ruler of 60 60cm has been developed next to the basic 4×4cm square. This allows every participant to apply the grid as a shared design tool while generating new parts, components or structures.
The OS grid is the centerpiece of the whole OS system. The grid is built up out of 4×4cm squares. The borders of these squares mark the cutting lines, its diagonals mark the assembly points and its enclosed inner circles define interconnecting diameters.
http://openstructures.net

Fig. 114
The Transparent Beehive is a node in the Ecological Corridors project.
The project was introduced during the 13th Kassel Documenta,
at the salon organized by the Critical Art Ensemble.
We put forward Ecological Corridors in urban environments
as a new medium of social sculpture, a Gesamtkunstwerk
that relies on the creative participation of many.

AnneMarie Maes (1955, Brussel) studied a masters in fine arts at the Sint-Lucas Academy of Fine Arts in Brussels, a masters of cultural studies at the University of Brussels, and a specialisation in anthropological documentary film at the Institute for Sound Image Culture in Brussels.
She has played a major role in organising the multi-media art scene in Brussels. She founded the Pix and Motion Experimental Animation and Short Movies Film Company, the artist-run "Looking Glass" exhibition space, and more recently, the international artist collective OKNO, which brings together artists and art spaces from different European countries to engage in workshops and open research labs.

Her artistic work shows several interwoven threads. One line of work focuses on multi-media installations. For example, in the No2pho (from noice to voice) installation (2006-2008) spectators shape a sound scape by moving around sound sources based on literary texts. Another line takes a social and anthropological dimension. Examples are the "People Database" project (1998-2002) which collected life narratives triggered by found pictures, and the "Politics of Change" project (2007-2010) which documented the grassroots activism of women in India. Her most important current line of work focused on ecological issues, as in the on going Open-Greens project (2009-2013) which sets up laboratories of urban gardens and art works based on monitoring bee colonies (2009-2013).
AnneMarie Maes has exhibited widely in international contexts, including in various European countries (Austria, Belgium, Croatia, Finland, France, Germany, Spain, Sweden, etc.) as well as the US (New York), Syria, India and Brazil.

http://annemariemaes.net