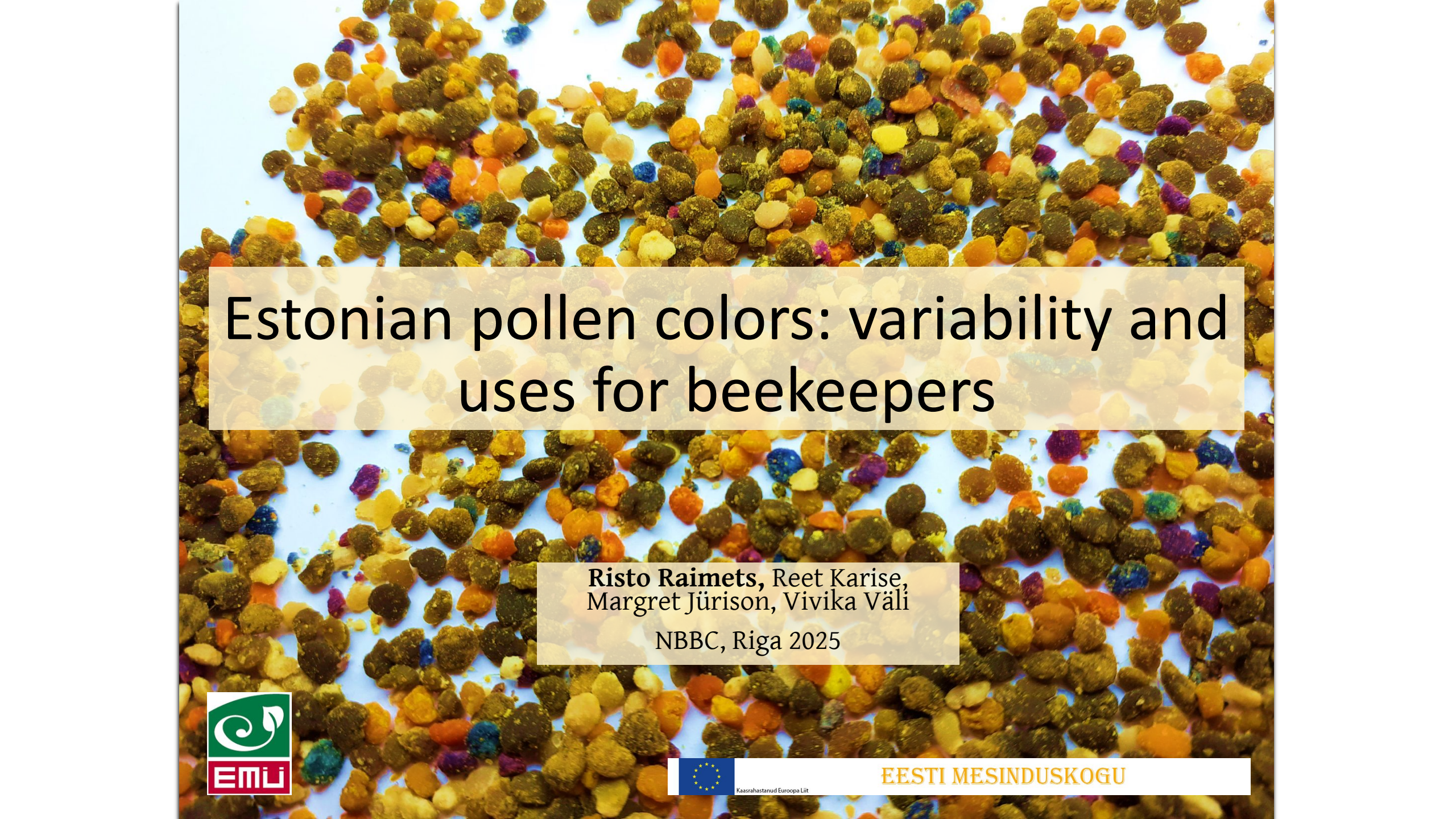




Estonian pollen colors: variability and uses for beekeepers

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EESTI MESINDUSKOGU

Cost-effectiveness of pollen color

- The production of dyes is costly for the plant – it has to pay off!
- Sometimes the plant doesn't want to get pollinated
 - Reduce visibility or availability (color change, fake pollen, low-quality pollen)
- By changing the color of pollen, plant can attract pollinators to the flower at just the right time or avoid visiting the flower
 - Green pollen helps to hide
 - Plant can play with the nutritional value of pollen – female kiwi flowers do not produce nectar, but attract with sterile, nutrient-poor pollen
- When a plant provides nectar at the same time as pollen, the pollen is often less brightly colored



Multiple colors of pollen on the same plant (Koski jt 2020)

- *Campanula americana* pollen from white to dark purple
- Flowers with dark pollen are more attractive and pollen survives better in hot conditions.
- Dark pollen grains are larger and richer in anthocyanins (protection from heat)
- More light-colored pollen was produced more at once, and 18% more seeds were produced.

P



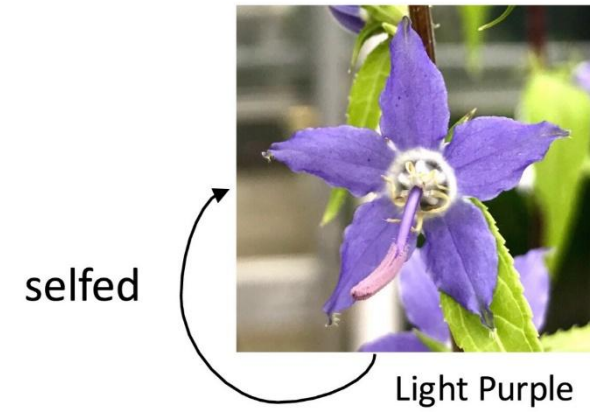
White

X



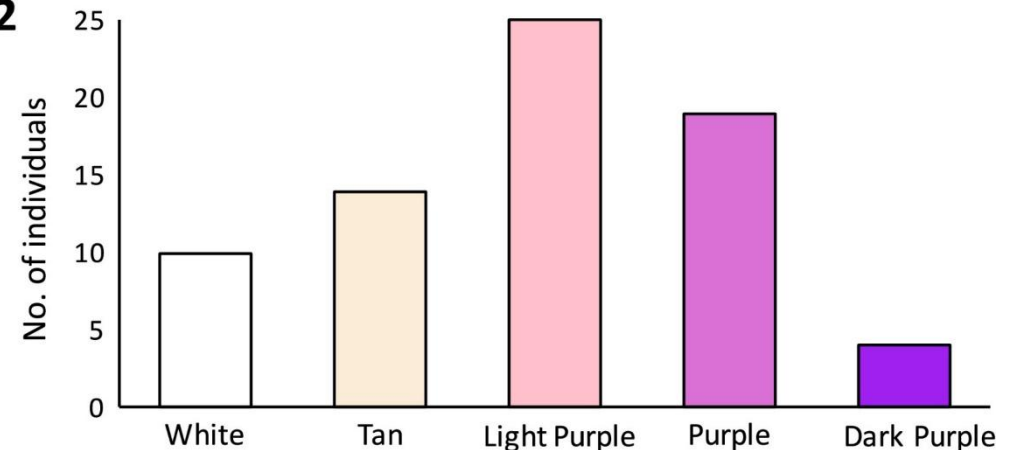
Purple

F1



Light Purple

F2



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aging

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massively

single

Corbicular pollen pellet color?

- It can be formed from
 - Single plant species
 - Multiple plant species
- Pollen grain color might be
 - Homogeneous
 - Variable
- The same plant species may have pollen with multiple colors



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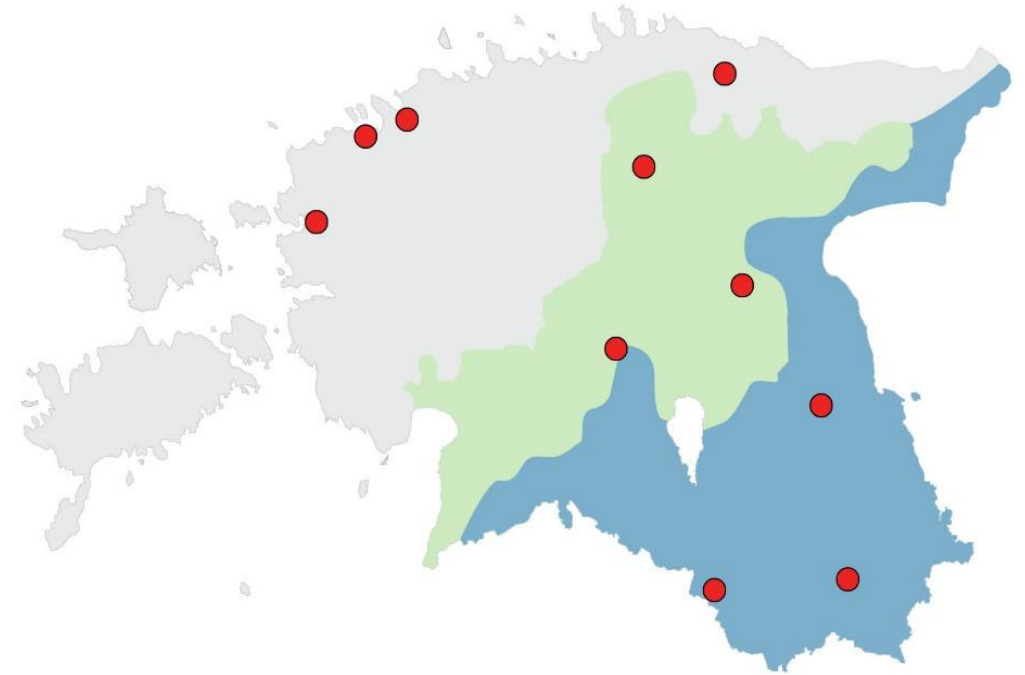
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Aims

- To find out of which plants the pollen collected by bees in Estonia comes from and how the species richness of pollen and plants varies by region
- To study the variability of pollen color in the main Estonian flowering plants and the factors that influence color variation
- Assess under what conditions it is possible to use the color of the pollen grain to determine the plant origin (species) of pollen

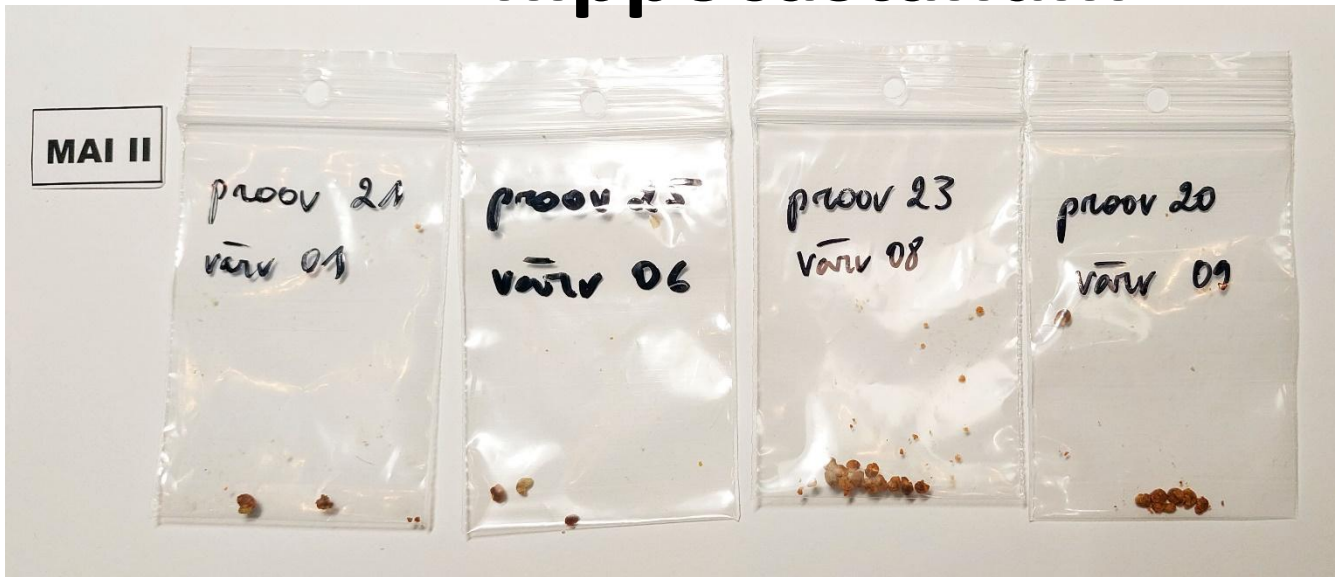
Methodology

- May-august. Every 2 weeks beekeepers collected pollen (7 samples) – in total 69 samples
- Fresh pollen stored in freezer (later we dried it in 40°C, 3 h)
- 15 g of pollen weighed from each sample and the pollen was then sorted by color. Sorted pollen groups were then weighed again and calculated the % from total
- From each sample, three most prevalent colors were selected for botanical detection
 - Is the color species-specific?
 - Do the most abundant species vary over time and space?



- The pollen color changes in time and space
- The quantities change in time and space

Aesculus hippocastanum



Buckwheat



JUNE I

Red clover



JUNE I

White clover

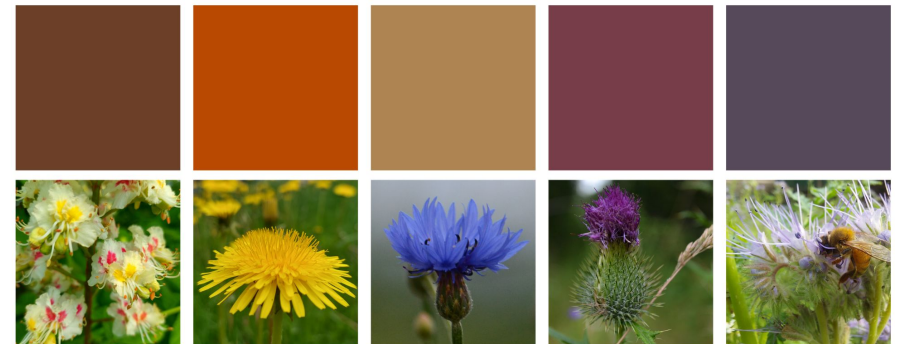
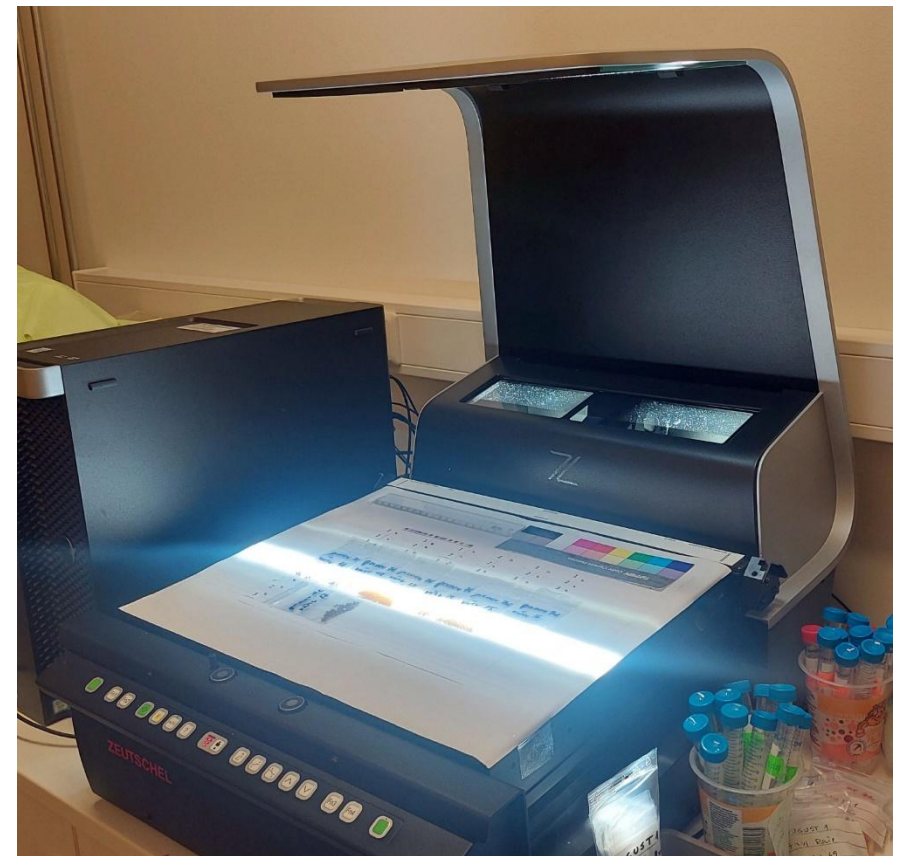


MAY I

Crucifers



- Uniform lighting conditions and a scanner were used to determine the digital color (Overhead scanner OS 15000).
- To assess the color variability, three different tonality pollen grains were selected from each pollen color group during scanning to determine the technical color (RBG code) (Borlinghaus jt. 2023).
- In the RGB model, the code is formed using three basic colors: R – red (red), G – green (green) and B – blue (blue), whose values can range from 0 to 255. The combination of different values of the three colors defines a specific color.



Pollen colors. Horse chestnut, dandelion, cornflower, thistles, Lacy Phacelia

Results we found?

- There are many colors, 3-18 colors at a time
- More frequent colors: yellowish, greenish, orange
- There are less colors in the beginning of May
- The richness of color in Western Estonia does not change over time
- In central and southern Estonia, the foraging beginning period is poorer, in southern Estonia the end of summer is the most colorful

Which plant species were determined?



- 42 plant groups
- crucifers (**14.8 %**), willowherb (**7.7 %**), dandelion (**7.0 %**), buckwheat (**6.7 %**) and fruit trees (**6.3%**)
- **1-5 %** : White clover, Meadowsweet, Broad bean, Cornflower, Umbellifers(apiaceae), Red clover, Cirsium, Lacy Phacelia, Horse chestnut, Potentilla, Anemone, Willow, Galega orientalis, Ranunculus, European field pansy, Mugworts, Calluna, Rosaceae, Brown knapweed, Viper's-bugloss, Mayweed, Sow thistles
- **Under 1 %** : Saussurea, Lychnis, Purple loosestrife, Sweet clover, Buckthorn, Common dogwood, Honeysuckle, Medick, Solidago, Milkvetch, Centaurea scabiosa, Sedges, Common juniper, Common poppy, Grasses (Poaceae)

Plant diversity?

- At the beginning of May, the number of plant groups is small
- Most groups in June
- The pollen collected in Western Estonia is the richest in species

More results

- We did not observe correlations between the pollen color and regions (plant species specific) – the number of samples was small
- Many plant species pollen is getting darker within the season (->)
- Some plant species pollen still stand out from others (dandelion (orange); phacelia (dark purple), aesculus hippocastanum (red-brownish); thistle (purpur))
- The taxa with the most variable color palette were: crucifers, rowan type, rosaceae, marana type and willow flower, which may be due to the fact that these pollen taxa contain many different species that pollen analysis cannot distinguish.

The plants bloom longer than bees visit them

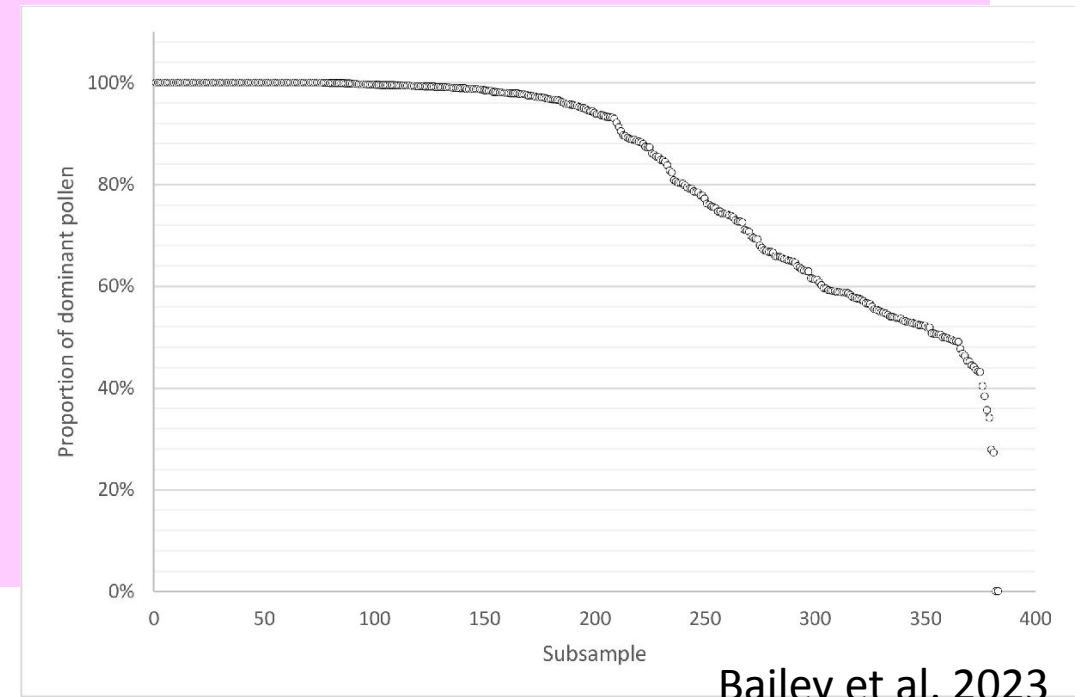
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Marana tüüp (maranad, maasikad)							
Harilik keerispea							
Kibe tulika tüüp							
Sarikaliseid							
Pajulilled							

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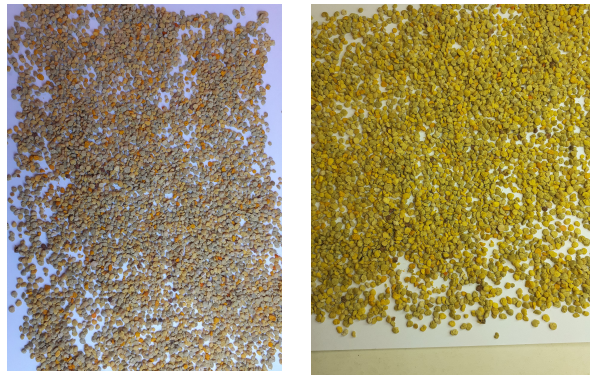
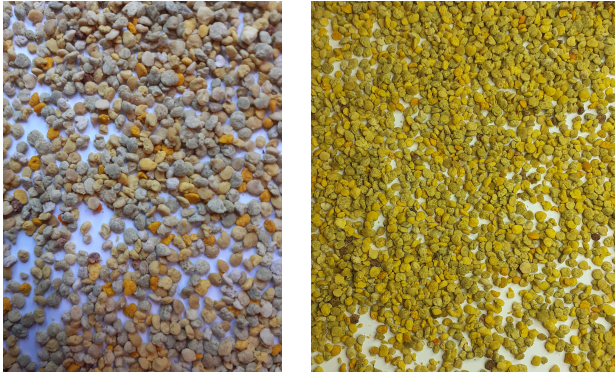
Issues that may affect determination by color

- Recurring colors in different plant species
- Variability of pollen grains - about 50% are of one plant species
- Assessing Pollen Color - People's perception varies
- Taking photos of pollen
 - Apparatus
 - Light conditions
 - Light reflected from the background



Determining by image does not work because it is a result dependent on the light, camera and objects in the background

- 2 different pollen mixtures
- Light conditions same
- Only angle and distance of the phone changed



Pollen sample number 1



Pollen sample number 2

Apps



Color
Grab



Color
Name



RGB Co
Detector

- First of all, the light must be standardized
- Then use some app(s)
- Let the app determine what is white under the given conditions
- The same app should be used throughout the research

46	60	62	65	72	74	<i>Epilobium angustifolium</i>
14	15	18	25	81		Rosaceae
16	52			97		Brassica <i>Calystegia sepium</i>
53	56			110		Vicia Chicoroideae
101	103			54		<i>Hedera helix</i> <i>Acer campestre</i>

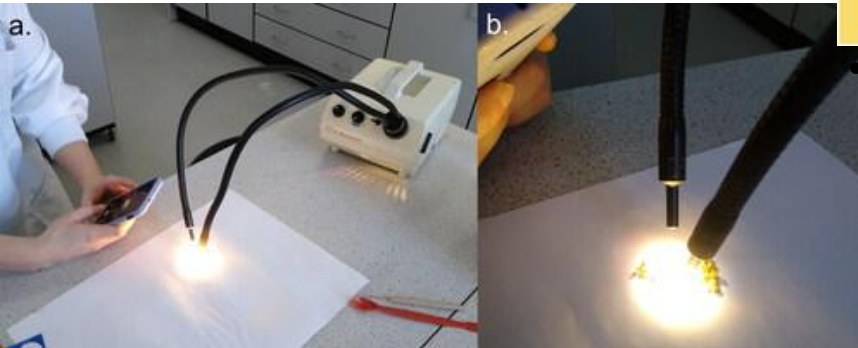
The same plant species collected from same place can have different colored

- Fireweed (*Epilobium angustifolium*)
- Rosaceae
- Brassica
- Vicia
- Hedera Helix (luuderohi)



Epilobium angustifolium

App 3	App 4	
		Android
		iOS
		Android
		iOS
		Android
		iOS
		Android
		iOS
		Android
		iOS
		Android
		iOS



Future

- Long term survey needed
- A color determiner could be a great tool and would be popular among beekeepers
 - Some plants pollen are still recognizable, using only colors and the collection time – a booklet!





Kaasrahastanud Euroopa Liit
Euroopa Põllumajanduse Tagatisfond

**Eesti
Mesinduskogu**



Thank you!



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