Towards an understanding of the relationship between forage plants, nectar, honey and the honey bee.

A study of 3 heathers and 2 plants from the Boraginaceae

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Start date: 2106
End date: 2024

A film 'Forage Plants and the honey bee' is available at https://youtu.be/wvkNz_gN7j4

This project began with a question about routine feeding of refined sugar to honey bees, a practice recommended by the British Beekeeping Association (BBKA). For beekeepers there's always a difficult decision to be made as to how much honey to take and how much to leave for the bees. Nobody knows what the future weather will be like and whether they will be able to make up the loss. If the beekeeper finds the hives are 'light' then sugar supplements are recommended but mostly beekeepers feed pre-emptively, just in case they need it and it struck me that this practice could be detrimental to bee health as they may be lacking nutrition that would be provided by nectar but not by sugar candy.

Diversity

There is a growing concern that the honey bee diet is impoverished by current landscape use and that their nutritional needs are not being met. This may be in turn having a detrimental impact on their health. (Brodschneider, 2010)

Is it enough that there is a smörgåsbord of floral sources available when required or are there other elements specific to individual floral nectars that are passed on in the honey and are important to bee health? Do we need to know more about what effect a specific plant source may have? It would seem that if we acknowledge the importance of diversity in the bee forage we imply that there are differences in each plant source.

Although there is acknowledgement of anti-bacterial and anti-microbial properties in honeys (particularly Manuka and Calluna) much of the research here has been in relation to human rather than bee health. Volatile oils and trace elements are small in quantity but do contribute to the character of a particular plant's nectar and therefore its honey. Would there be a way to discover their effect, if any, on bee health?

Silvio Erler and Bogdan Gherman have shown how honey bees can use their stores as an in-hive pharmacy to self-medicate, choosing particular types of honey with anti-microbial properties when the colony was suffering from a gut parasite (Nosema, a microsporidia) that causes dysentery-like symptoms. Erler has shown too that nurse bees selected different stored honey when the colony had EFB (European Foulbrood) – black locust honey, and sunflower honey for AFB (American Foulbrood). (Erler, Diversity of honey stores and their impact on pathogenic bacteria of the honeybee, Apis mellifera, 2014), (Erler, Pharmacy bee hive — use of natural drugs to increase pollinator health, 2016), (Gherman, 2014).

I chose to approach these questions from the plant side. Studying a plant with Goethean science can help to reveal its relationship to the human being and health. By focusing on the phenomena, the plant, one can hope to understand its essence and to be able to predict its therapeutic use.

The bee and its relationship to its forage plants is less well understood however.

My question has become: is it possible to make a connection between the plant individuality, its honey and the wellbeing of the bees?

What I hoped to do in this study was to understand the plants' qualities at a deeper level so that we might be able to understand better the effect of a particular honey on bee well-being and to have a better idea of how to investigate further.

I selected 3 plants from the Ericaceae (heather) family to study:
Erica tetralix – Cross leaved heather
Erica cinerea – Bell heather
Calluna vulgaris – Scottish heather or ling

Later I introduced two plants from the Boraginaceae family to compare with the heathers: *Borago officinalis* (borage) and *Symphytum officinale* (comfrey).

Heathers

Habitat

"Our task, then, is to learn to see plants in such a way that each species' place within the overall organism of the plant world becomes apparent, just as within the human organism each human organ has its place." (Steiner, Agriculture Course, 1924)

The moorland home of heathers can be cold, wet and inhospitable. Heath and moorland are virtually synonymous with wildness. Emily Brontë's "Wuthering Heights" personifies the wild untamed moors in her character Heathcliff while the heroine Catherine is torn between her wild heart and quiet respectability of the so-called civilised world.

The word heathen comes from the Old English hǣthen, of Germanic origin. It is related to the Dutch heiden and German *Heide*, from the base of heath, and means both 'inhabiting open country' and referring to a person who does not belong to the Christian religion.

The only truly natural types of heathland are montane, maritime and bog heath. Heathers are pioneer plants that would be superseded by taller plants such as trees in all but the most hostile situations. Montane heath is found at high altitudes (above about 700m), where exposure prevents the development of taller shrubs or trees and maritime heath is found on lowlands or cliff tops, where strong, salty sea winds keep the vegetation low. In Britain, Arne heath on the south coast is being 'rewilded' currently. It will be interesting to see how the natural balance establishes itself.

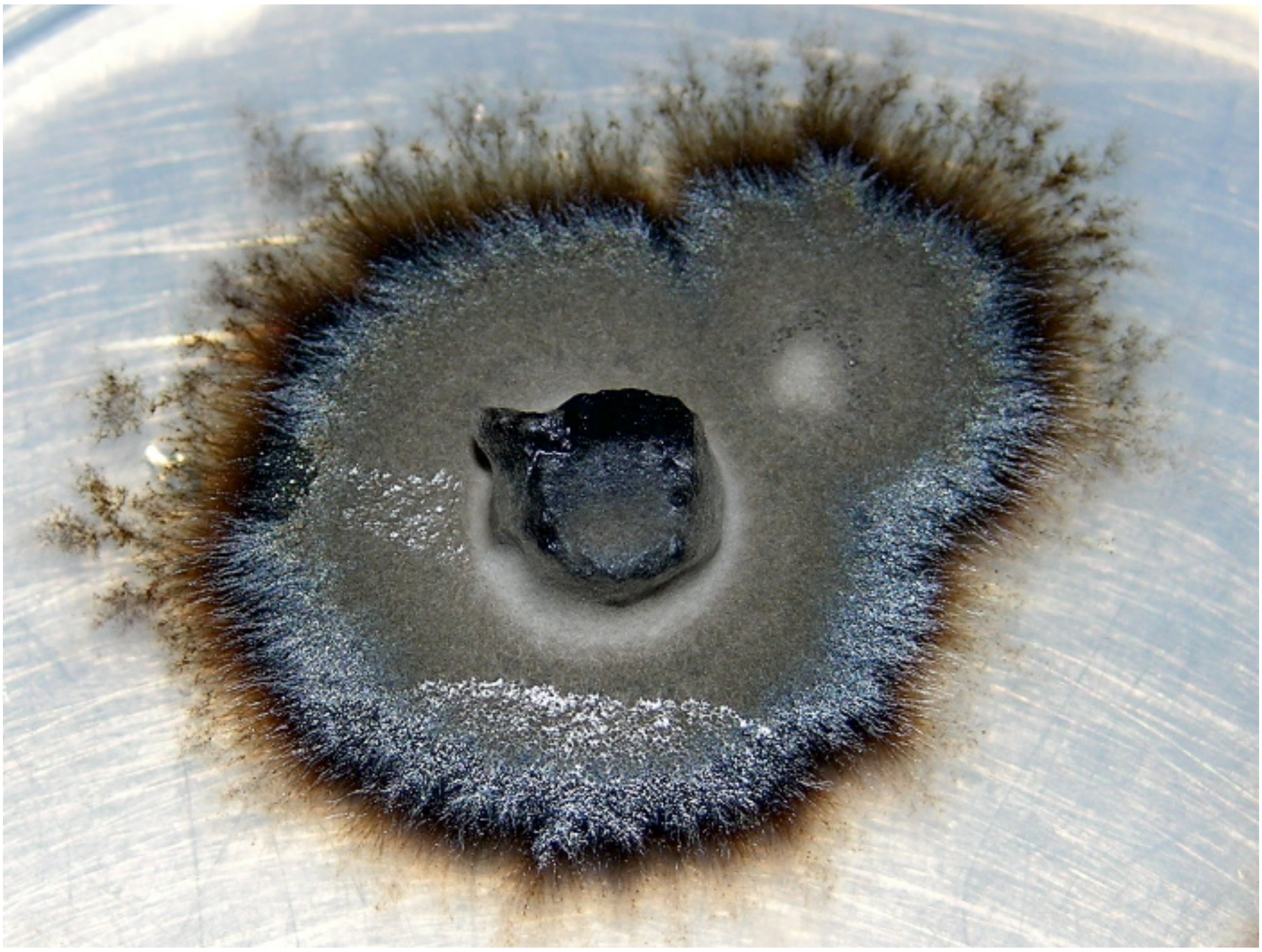
The rest is "semi-natural" habitat, requiring human intervention to stop it developing into woodland. Much of the heathland in the UK was created back in the Bronze and Iron Ages by clearing forest so it could be grazed, used as bedding for animals and the peat used for fuel. Nowadays much of it is managed. There are cycles of burning which stop it returning to forest and gives the heather a chance to regenerate. Fire prevents the heather becoming leggy and woody, and the new growth is fodder for grazing birds like the red grouse in Scotland and other grazing animals such as sheep, deer and hares. There are rules about the burning – it should be done in rotation and usually about every 15 to 20 years, and only at certain times of year, not when birds are nesting or in the summer when there might be a threat of the fires becoming uncontrollable. But there is controversy over the practice. There's strong support from the grouse shooting industry but concern from conservationists over loss of flora and fauna ie sphagnum moss species; the meadow pipit; and of the effect on the water table.

Peatland has been drained and burnt as fuel for centuries. It covers just 3% of the world's surface but acts as a carbon sink for 42% of all soil carbon! (IUCN, 2017) (IUCN, 2018). Essentially non-renewable as it takes thousands of years to create, this type of landscape is increasingly threatened worldwide.

In the UK the environments where heather communities are ecologically stable and wouldn't be succeeded by woodland, are challenging with strong winds and cold, wet weather, so it is unlikely that honey bees would survive in many of them, especially further north. And it is questionable as to whether there would be sufficient forage for the rest of the year in such areas. Bees are brought in to the more remote heathland and moors when the heather is in flower and are removed afterwards. They could perhaps have lived close by in wooded areas but it seems that often man has to play an intermediary role for honey bees to access a crop they are so fond of.

By contrast, in the Landes region of France, a maritime region surrounded by pine forest, honey bees not only exist but have developed an ecotype to co-exist with this particular heath landscape. Their yearly cycle of brood rearing has evolved to coincide with the availability of their heather forage (Strange, 2007).

Heathers like moist air and plenty of light. The whole Ericaceae family prefer an infertile, acidic soil. They are able to live in a wide variety of conditions thanks to their symbiotic relationship with mycorrhiza. Their roots don't penetrate deep into the soil but remain just below the surface in a dense mat. All 3 heathers have rootlets, extremely fine roots that are penetrated by the mycorrhiza making it almost impossible to separate the rootlets from the soil. This special mycorrhiza helps the Ericas obtain nutrients – mainly nitrogen – where very little sustenance is available. This also explains why the heathers can live in such different soil conditions: Erica tetralix in bogs, Erica cinerea on free-draining sandy soils and even on rock and Calluna vulgaris on a range between the two extremes.

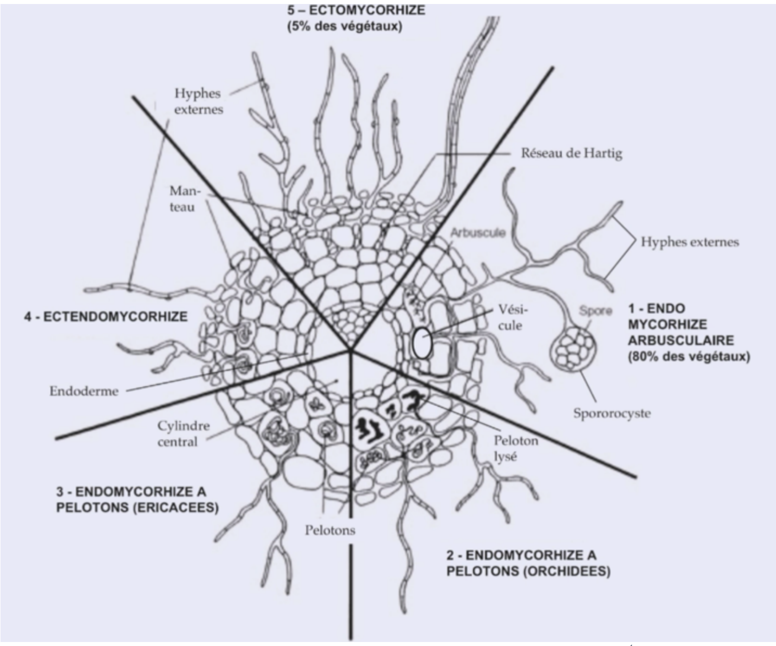


An example of an Ericoid mycorrhiza[1]. *Cross section of root of* *Woollsia pungens*[2].

[1] This is an unusual type of mycorrhiza, something between an 'ecto mycorrhiza' and an 'endo mycorrhiza' ie the association with the fungus is superficial as well as internal. (Harley, 1987 (Suppl.))

[2] by Dr David Midgley at English Wikipedia., CC BY-SA 2.5 <https://creativecommons.org/licenses/by-sa/2.5>, via Wikimedia Commons

Another Ericoid mycorrhizal association [3]



Different mycorrhizal types Marc André Selossse [4]

The plants have a spreading tendency. Their lower branches are able to put out roots where they touch the soil and it can be difficult to define where one plant stops and another starts.[5]

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[3] *Cairneyella variabilis* by Midgley DJ, CC BY-SA 3.0<https://creativecommons.org/licenses/bysa/3.0>, via Wikimedia Commons

[4] Marc-André Selosse, CC BY 2.0 <https://creativecommons.org/licenses/by/2.0>, via Wikimedia Commons

All heathers have a characteristic springiness, bouncing back after being trodden on. They do become woody and brittle with age however. The wood burns well and used to be collected as firewood.

Distribution

In the northern hemisphere there are relatively few heather species, around 20, but they cover large amounts of ground.

In contrast, in the southern hemisphere – specifically southern Africa – there are more than 600 species but each covers only a small area and there is a huge variety of forms and colours.

In the areas I studied, in fact in most of Britain, my three heathers are the predominant species. They also dominate northern European heathland, with a few additional species such as the Cornish heath *Erica vagans*, Dorset heath *Erica ciliaris*, Irish heath *Erica erigena* and *Erica carnea* from the Alps.

Moving south towards the Mediterranean and a warmer climate, more species occur but the forms and colours don't have the range of the Cape heaths. The flower colours appear to correspond to the pollinator-type: shorter corolla tubes for pink, purple and white flowers, which are pollinated by insects and longer corollas of flowers, which are red, orange or yellow and are pollinated by birds. No Ericas have blue flowers (Rebelo, 1985).

They are small, slow growing shrubs that can live for up to approximately 40 years. They grow between 10 and 50 cm tall and spread up to 50 cm. The exception is *Erica arborea*, which can grow to 7 metres although more commonly up to about 4 metres. Its wood is very hard and heat resistant.

EXACT SENSORY PERCEPTION

Erica tetralix. **Cross leaved heather. Glockenheide**

Such a gentle soul
Grey in winter almost not here
Palest pink, shy and demure in service
You could disappear in your delicacy, palest pale
So soft yet strong
Fairy touch
Tiny undiscovered beauty of the bogs
Weaving magic to the dead waters
Not alone, not isolated
Together in the wilds

Not alone, a collection of strangers together in adversity
Each carving their niche
Bringing light to the bleak, windswept empty spaces
Bringing life to the emptiness
Grass of the moors?
Demure, quietly, softly at work
Unseen, no reward

Soft, gentle *Erica tetralix* lives in wet, boggy soil conditions. The colour can vary from white through to the palest pink to a darker pink that gets stronger when the ground is drier.

Even in flower it disappears into the landscape, virtually invisible. The pale pink of the flowers merges into the soft grey leaves.

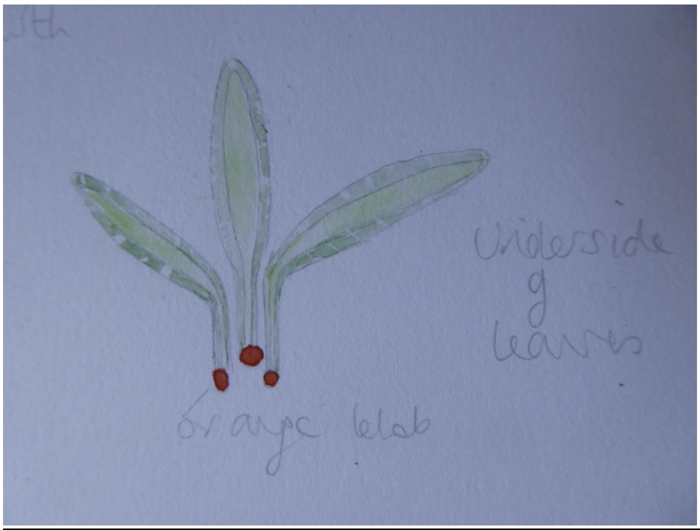
<u>Roots</u>
Erica tetralix´s roots are typical of the Ericaceae, as described above.

<u>Branching</u>


Each new year's growth is not branched and gives a snake-like impression, as if uncoiling with the head angled horizontally. There is a radial branching after flowering. Stems can have side shoots.

<u>Stems</u>
The young stems have white (non-glandular) hairs.

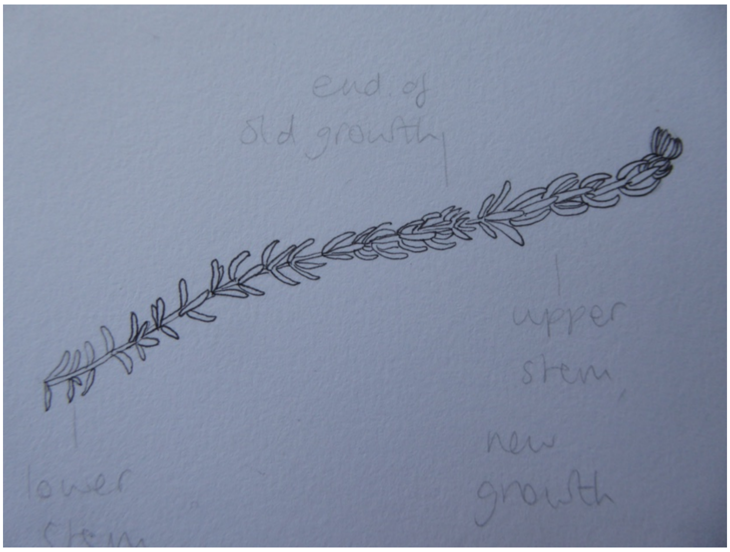
Leaves



Leaves are evergreen and needle-like, 4 per node. The edges roll under, a drought tolerance feature. They are grey and covered in *glandular* hairs, particularly at the edges. These have a glassy appearance. The orange 'blob' at the end of the hair is sticky.

There is also a shiny orange bulbous base to each leaf where it attaches to the stem.

The leaves at the bottom of the stem are recurved, those in the middle are at right angles to the stem and those towards the top face upwards. Each leaf is identical, no metamorphosis can be seen.



<u>Calyx</u>
They have 4 hairy sepals. The glandular hairs are the same as on the leaves, not the stem.

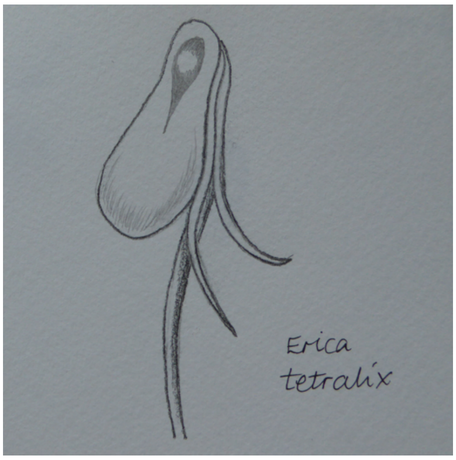
<u>Corolla</u>
The corolla has bilateral symmetry with 4 petals which are fused to create the characteristic bell shape which opens only at the top of the flower. The pale pink flowers appear in a whorl at the top of the stem and hang down to face the earth. The outer flowers blossom first.

Stigma

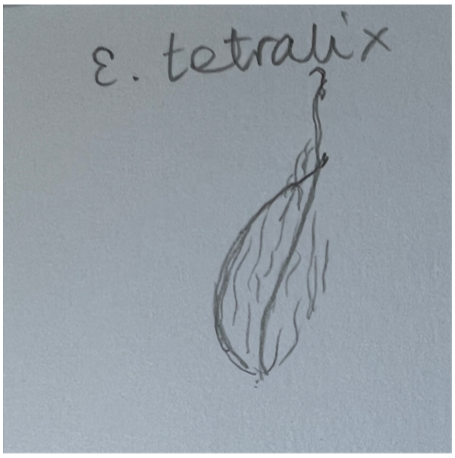
Stamens with open pores and pollen

They have a superior ovary.
There are 8 stamens which are not attached to the corolla.
Anthers have awns or 'a bicorne', a forked tail at the base. The filament is flat. Hagerup suggests that the bicorne helps self-pollination in Erica tetralix (Hagerup, 1953).

They release the pollen via pores, 2 per anther. The pollen grains occur in tetrads.



Awns



Hairy capsule

<u>Fruit/seeds</u>
After pollination the flowers become brown and dry, and then turn up to face the sun.
The ovary develops into a hairy capsule with 4 fused carpels and many seeds.
After a few weeks the seeds become hard and dry, the fruit splits open and the seeds are dispersed.

<u>Thrips</u>
Thrips (*Taeniothrips (Amblythrips) ericae* Haliday) are approximately 1mm long and can spend part of their life-cycle in *Erica tetralix* flowers. They have been recorded feeding and breeding in various Erica and Calluna species in Britain but also in Vaccinium and Arctostaphylos in Europe (zur Strassen, 2003) (Bhatti, 1990) (LA Mound, 1976). They share the Paraneoptera insect categorisation with booklice and other lice, and true bugs. See Appendix E

Taeniothrips (Amblythrips) ericae Haliday

The small, winged thrips are all females. The males are very rare and are wingless: so far more stationary than the females, who have to hunt for the males. The larvae develop in the blossoms, but at the 2nd instar stage (shedding of its skin which doesn't grow) and propupae stage, they drop to the ground.

E. tetralix has sticky hairs which can trap insects. It is considered 'proto-carnivorous' which means it doesn't digest the insects itself (it has no digestive enzymes) but can use the frass (excreta) for nutrients.[6] The relationship is more mutualistic as the insects provide nutrients and pollination and the flower provides shelter, a home.

Sundews grow side by side with *E. tetralix* in the New Forest. They are true carnivores with enzymes that enable them to digest insects.

[6] A study in 2005 showed that in a plant, Roridula, that captures insects but has no digestive enzymes, insect faeces are absorbed through the leaf cuticle. (Anderson, 2005)

***Erica cinerea*. Bell heather. Graue Heide**

Tinkerbell blooms full in colour
Bold, intense. Robust
Out of the water into the silica sand
Perfectly formed, clarity of the bell
Almost spiky but not – rounded ends
Needles, darker, concentrated colour
Yet somehow mysterious in your three-ness. What goes on in those partings?
Pulled out, further away?
Soft stem – a nod to your cross-leaved sister.

Roots

The roots are as for *Erica tetralix.*

It likes dry, sandy soil conditions and can be seen living directly on rock.

Branching

Like *Erica tetralix* they divide after flowering with branches condensed near a point, almost in a whorl. Side shoots can come from nodes on each new branch.

Stems

The young stems have a downy, grey covering giving it its German name, 'Graue Heide'.

Leaves

Leaves are evergreen and needle-like. They can vary between light and dark green and have few, small hairs. They circle the stem in whorls of 3. New growth comes from one of these nodes. Like *Erica tetralix* the leaves have a bulbous base, although here it is less pronounced.

Grey hairs on stem

Leaves in whorls of 3

Interestingly they do rotate around the stem – turning 60° and then returning to the initial position after the one intermediate whorl.

Calyx

They have 4 sepals, much smaller than the corolla.

Corolla

The corolla has bilateral symmetry like *Erica tetralix*, with the 4 fused petals.

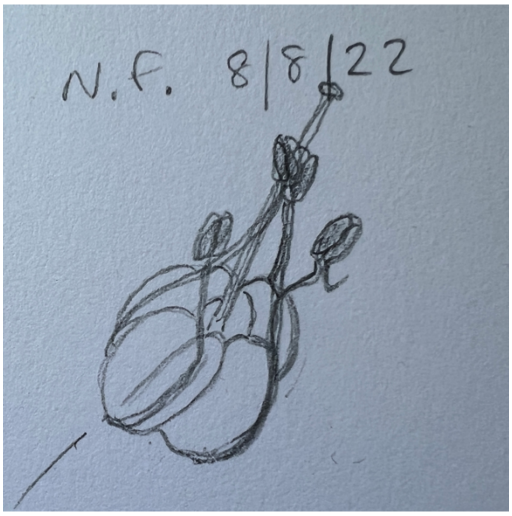
The striking magenta flowers appear in a whorl at the top of the stem, the lower flowers opening first as the buds above slowly develop. They also appear from sideshoots lower down the stem. The lower flowers come into bloom after the top flowers.

Like *Erica tetralix* they have 8 stamens that are not attached to the corolla. However here the anthers have no 'bicorne'.

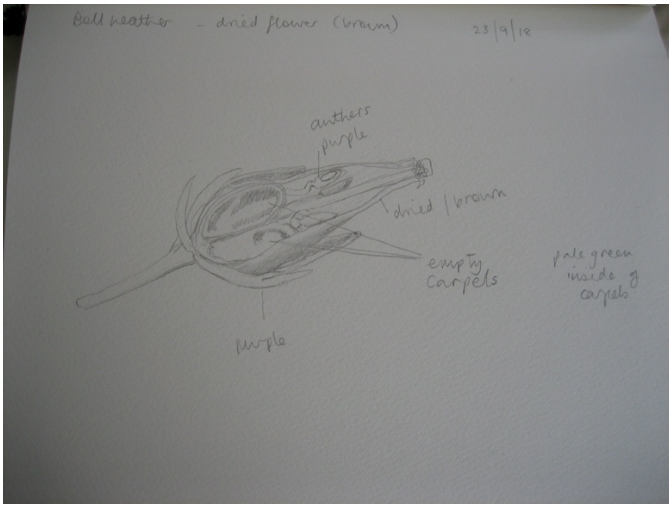
Fruit/seeds

There is a superior ovary that develops into a capsule of 4 fused carpels.

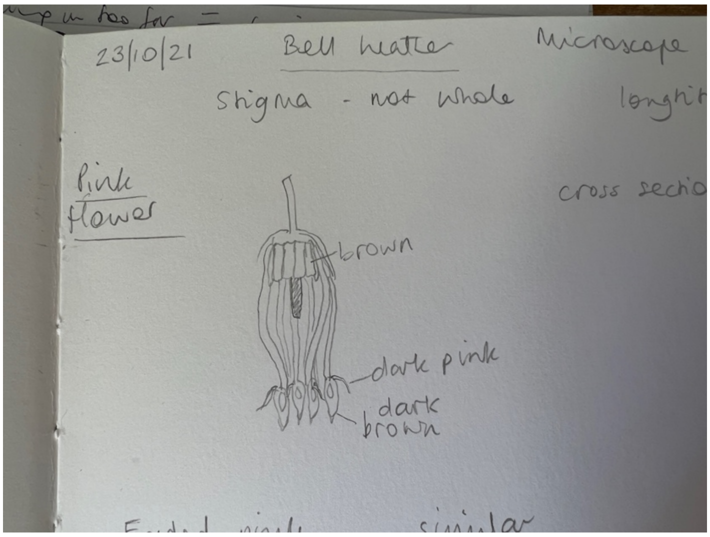
Like *Erica tetralix* the flowers become brown and papery after pollination, and turn upwards. They can still be present on the plant the following year and can take a mummified form.
The seeds, slightly larger than *Erica tetralix´s* come from non hairy capsules.



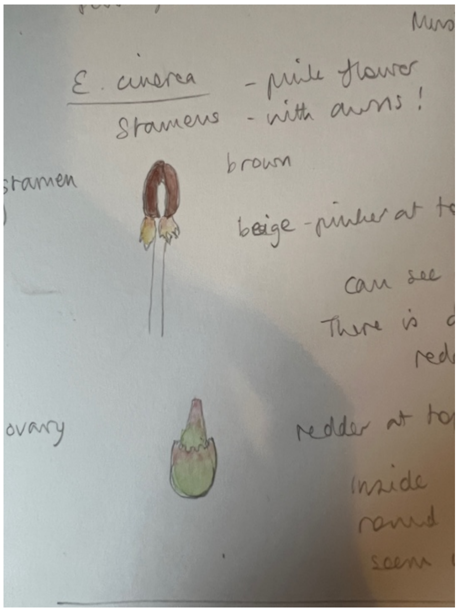
Non hairy capsule



Carpels, stamens and pistil, cross section



Stamens, cross section

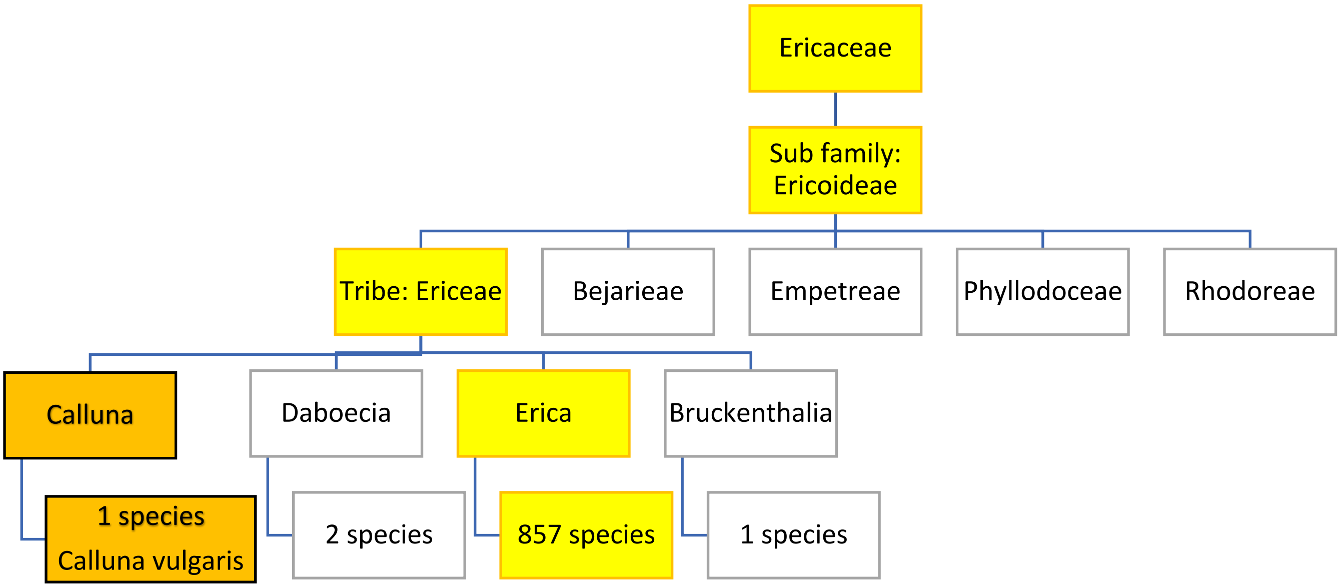


Stamen (above) Ovary (below)

Calluna vulgaris. **Heather, Scottish heather or ling. Heide, Heidekraut**

Stranger in a strange land.
An open Erica – defying, opening only to close in dying
Separation here, more ‘normal’
Conifer-stunted excuse for leaves
Stubs that widen and open
Open to the wilderness – welcome! Welcome (briefly)
Now it’s hospitable, transformed landscape
All colour, a carpet of pink
The time is now, warm and inviting
Before we return to cold, wind, driving rain and snow
To lie quiet again, unseen, out of mind, forgotten
Waiting, tough and wiry, staying flexible, poised and patient in the wilderness
Until next year
The sun pokes through and shines
Lights up all around
I’m here, look at me, at us all
How can it be? You hadn’t noticed and look how we are strong in numbers
We don’t go away
We’re always here, waiting, waiting,
For the time to be right

Calluna varies enough in the leaf and flower regions that it has earned its own genus, of which it is the only species.



It can live in wet, boggy soil conditions as well as on free-draining mountainsides and everything in between.

Roots
Calluna´s roots are typical of the Ericaceae.

Branching
Stems branch after flowering, radiating out from the main stem. They can become top heavy which pulls them back to the ground.

Older branches become woody and can develop a twist. As they age they become brittle and break off easily. They have traditionally been used as firewood, being flammable.

Stems
The stems have a downy covering.

Leaves
Leaves are evergreen and scale-like. There is no leaf stalk, they attach directly to the stem. They are simple with 2 leaves per node, and are opposite decussate, with no hairs.

These scale leaves begin tightly bunched and open out as the plant grows. They are often tinged with red. Each leaf has a pair of stipule-like lobes at the base. These lobes are only seen when the stems elongated.
There is no obvious change to the leaves from the bottom to the top of the plant, no metamorphosis except perhaps a slight pointing.

<u>Calyx</u>
At the base of the flower is a whorl of 4 bracts.

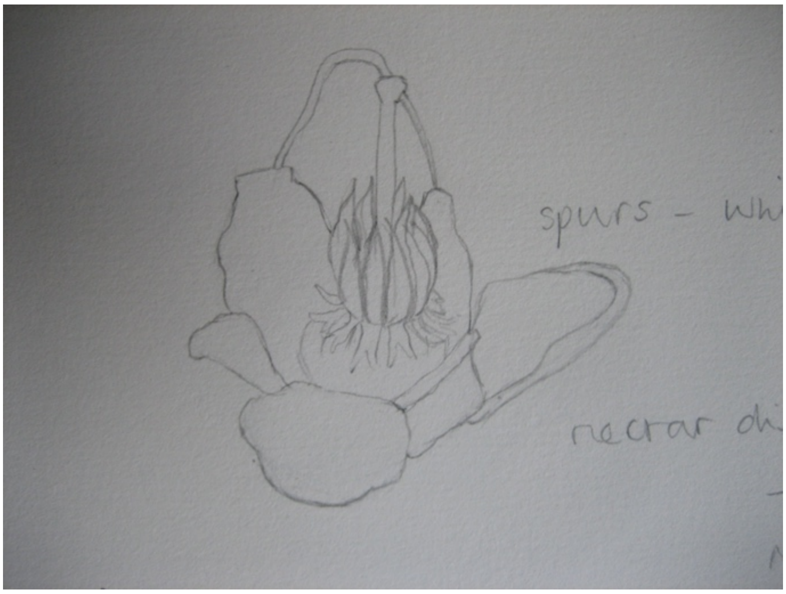
The calyx is petaloid, the same pink as the petals, with 4 sepals, which are <u>longer</u> than the corolla and similar in shape to the petals but waxier.
There can be small, hairy scales along the stem, which can also appear at the base of the inflorescence.

Scales on Calluna stem


Scales at base of inflorescence. Outer, larger sepals and inner, smaller petals

<u>Corolla</u>
The corolla has radial symmetry and again has 4 petals. They open fully and are only fused at the base unlike the other Ericas. Petals alternate with the sepals and are more delicate than them.
They flower all the way up the stem, the first flowers opening from the bottom up.

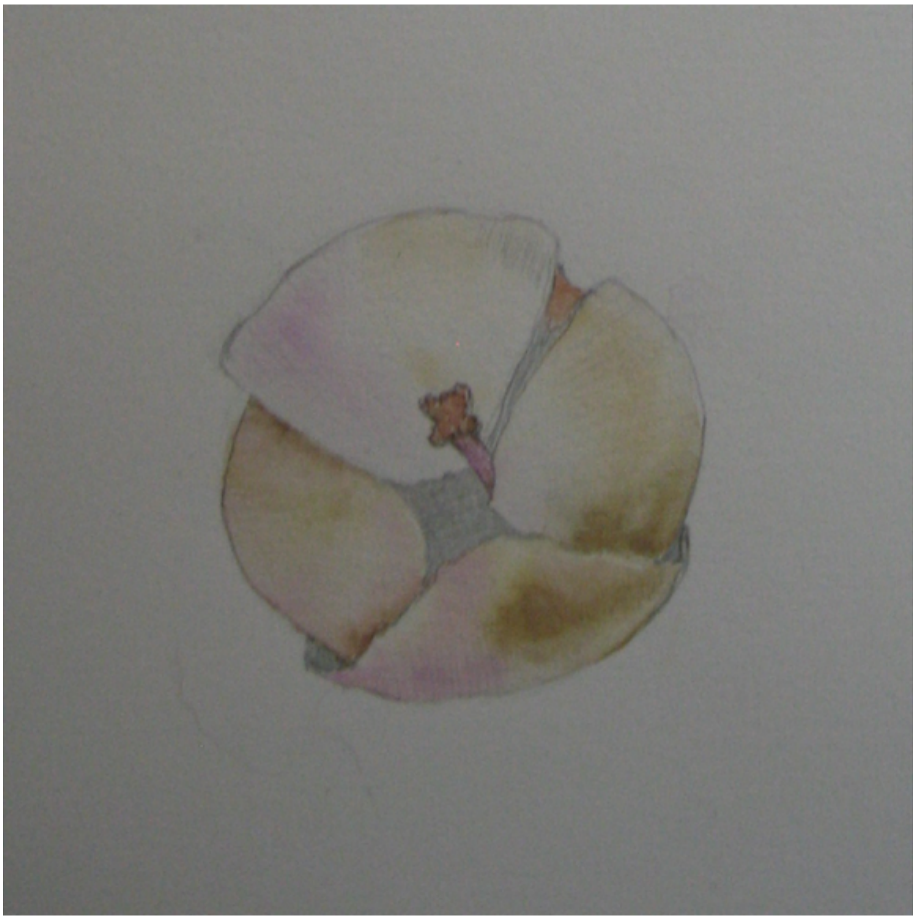
They have a superior ovary.
There are typically 8 stamens that are not attached to the corolla and the anthers have a white spur at the base, shorter than the awns of *Erica tetralix*. The anthers together form a cone and their pores open from within the cone. Pollen grains occur in tetrads. When a bee touches the spurs or the anthers, the pollen falls on them.



Calluna vulgaris. Spurs at the base of the stamens

<u>Fruit/seeds</u>
After pollination the calyx and corolla close in again leaving the pistil hanging out. It is then possible to see the rhythmic nature of the flowers along the stem.

After ripening the many seeds become hard and dry and the fruit, a hairy capsule (4 fused carpels), splits open and the seeds are dispersed.


Calluna sepals closed after pollination

Chemistry

Calluna vulgaris

A recent review study of the chemical composition of *Calluna vulgaris* plants identifies the main bioactive compounds, the phenolic compounds being the most noteworthy, as follows:

Phenolic acids - hydroxycinnamic acid, caffeic acid, coumarins

> 'Heather is also rich in phenolic acids, which are well known for their antioxidant ability by donating hydrogen or electrons. Meanwhile, their stable radical intermediates can prevent the oxidation of many food ingredients, especially fatty acids and oils.
> The lowest total phenolic content was found in the heather flowers.
> The whole plant seems to have the lowest total phenolics in autumn and then keep rising until reach a peak in spring.
> The antimicrobial activity does not necessarily correlate with total phenolic content in heather' (Zhao, 2011).

Flavonoids - rutin, quercetin, isoquercetin, kaempferol, luteolin, apigenin
Phenols and their glycosides - hydroquinone, arbutin, methylarbutin
Tannins
Triterpenes
Anthocyanidins
Terpenoids - lupeol, ursolic, oleanolic acids

> Ursolic acid is also present in Labrador tea plant (*Ledum groenlandicum* Retzius), an Ericaceae species widely spread throughout North America; blueberry and other *Vaccinium* species
> Oleanic acid has been used for liver diseases

Organic acids
Steroids
Essential oils and their subclasses
(Cucu A.-A. , 2022)

Studies of both the plant and the honey (Braghiroli, 1996), (Cucu A. , 2022), (Dezmirean, 2015) have been done to show antibacterial activity against many different bacteria including *Escherichia coli*, *Enterococcus faecalis*, *Proteus vulgaris*, *Listeria monocytogenes* and *Staphylococcus aureus*. Along with Manuka honey *Calluna* honey shows the most antimicrobial activity of all honeys. Other health claims refer to its antioxidant, antiviral, anti-inflammatory and photoprotective properties. It has been used historically for urinary tract infections as well as a variety of common ailments.

Ludger Simon about the chemistry of the Ericaceae family

Polyphenols are typical in the Ericaceae family.
Tannins work on the human organism, energising the human soul (astral body) and pulling it more strongly into the area of life forces, especially in the metabolic-limb systems. Acids (as in tannic acid) strengthen the astral body and pull it into the physical etheric.
Arbutin also works in this direction – a more strongly engaged astral body better masters the life forces and thereby works against the parasitic proliferation of foreign etheric living beings – bacteria.

Terpenes are the second characteristic substances of the family, ie triterpenes and diterpenes. Triterpenes & fat soluble, oxygen-poor diterpenes are in the waxy leaves.
Water soluble and oxygen-rich diterpenes are in contrast biologically active. These are the bitter stuff of the Labiates and the plant growth substances, gibberellins, that promote and regulate the sulfurish extension into space. They include the skin irritants of Euphorbias and Daphnes, and grayanotoxins, specifically andromedotoxin. Through combining with nitrogen compounds (amines) they are among the strongest poisons (diterpene alkaloids) found for example in monkshood (Simon, 1996).

Very little work has been done to look at the effects of any nectar or honey on bee health although a study by Koch looked at the effect of various honeys on a bumble bee mite. *Calluna* honey caused the bees to remove the flagella by which the mite attaches itself to the bee. I have puzzled over this but am still amazed that a food can result in a direct behavioural action! (Koch, 2019).

There are very few studies on the chemical composition of the other two *Erica* species. I have noted below where information is available.

Erica cinerea

Polyphenols

Plants presented a great diversity of compounds, with 33% flavones, 28% flavanols, and 26% hydroxycinnamic acids. (Aires, 2017)

Erica tetralix

Zhao compared triterpenoids in *Calluna* and *E. tetralix*. In all cases, *Calluna* held the larger amounts of them. (Zhao, 2011)

Substance chemistry in the **Ericaceae** goes also in the direction of nutritious fruit with larger quantities of vitamin C. There are no toxic
constituents.

GESTURES OF THE HEATHERS

All three heathers show great resistance to decay. The leaves (needles/scales) are evergreen and, as we've seen, the flowers can stay on the plant for months, sometimes still present when the following year's flowers are there. They contain a high proportion of tannins and historically the plants were used in the tanning process.

The first of the heathers to flower is *Erica tetralix*, from June to August, followed by *Erica cinerea* which begins in July and finally *Calluna* from August to late September. This covers their main flowering time but they all overlap and you will see stragglers continuing boldly past their documented times. Other members of the family flower at different times of year, notably *Erica carnea* in winter. Hybridisation has meant that there could be one or other type of heather in flower all year round. The family's ability to flower all year round shows an independence from the sun and annual rhythms ie. the growth doesn't depend on the increasing power of the sun.

In 1997 a German plant breeder, Kramer, developed a form of *Calluna* where the flowers never fully open. Known as the Gardengirls®, these heathers have been a commercial success because the flowers, not being pollinated, remain in a permanently youthful state, indeed they are known as 'bud bloomers'. They remain colourful throughout the winter. Although this has been a success for Kramer, unfortunately it has been less good for the bees as the Gardengirls® offer no bee food.
This development highlights the family's ability to 'hold back'.

Calluna is bred horticulturally for coloured foliage too, which can be silver, green, yellow, red, or even a blackish green. Here we see a feature from the flowering impulse coming further into the plant.

The Goethean method

The first stage of Goethean science is exact observation (Exact Sensory Perception), using the senses to carefully examine the phenomenon, here the plant, at each stage of growth. Whilst we can only ever see a snapshot image of the growing plant at any one time, with our imagination we can put together the different stages of the lifecycle, growing the plant in our mind's eye. This is the second stage, 'Exact Sensorial Imagination'. The plant's very 'living-ness' is thus included in the study.

At this stage, relationships are also looked at, for example to other members of the species, the family, to other plant families and to the surroundings. Here sequences are sought, for instance the leaves from bottom to top of the flowering stem.

One comparison that can be made is between the plant you are studying and an archetypal plant. Goethe was always looking for the 'Urpflanze', an ideal or archetypal plant. Through this search the discovery of the plant as essentially 'leaf' was made. "The leaf" metamorphoses into the different aspects: green leaf, sepal, petal, stamen and carpel. Rudolf Steiner took it a step further, noticing the essential disquiet (German: Unruhe), a never resting nature of the plant.

THE PLANT ARCHETYPE – AN ANNUAL
There are certain gestures typical of each stage:

Seeds Usually many Development in the dark, hidden inside Independence from the mother plant when ripe Hard, dry, contraction
Fruit Waiting, receiving, protecting Closed off, creating an inside and outside Spherical, usually several carpels united Expanding while ripening, then hard and dry
Flower Light, colour, scent Refined substance Opening
Leaves Planar, spreading horizontally, substance production Spiralling up stem Metamorphosis Contraction into calyx where the movement upwards is halted
Stem Vertical Between earth and sun
Roots A radial character Branching, division, symbiosis with mycorrhiza Earthy – tendency to become hard with age although tips always young and active

By imagining such an archetypal plant, we can gauge where our plant is different and so look to these features to help understand it.

Heathers and the archetypal plant

Heathers' leaves are weatherproof, are simple and lack any development or metamorphosis. There is ***contraction*** rather than archetypal expansion and spreading here, as if their form is compressed.

The way the leaves are arranged around the stem differs between the 3 species – *Calluna* having 2 scale leaves per node and opposite decussate, *Erica cinerea* having 3 nodes in a whorl, *Erica tetralix* having 4, also in a whorl.

There is hardly any of the spiralling upwards typical of leaves' progression along the stem as seen in the diagram above (note: *E. cinerea* does rotate, the leaves are not aligned for one level then they realign and *E. tetralix* also shows a rotation between each whorl of leaves). The branches all appear after flowering in close succession as if the potential spiral has been condensed. This is suggestive of the calyx of the archetypal plant, where the leaves become thinner and smaller, where no metamorphosis is seen and they no longer spiral up the stem.

The regularity of the whorls in the heathers and repetition plus the specific number at each node exhibits a rhythm. So an interpenetration of flowering and rhythmic gestures in the green, leafy area is at work here.

Growth continues after flowering, fruit and seed, and then the stem divides in a radiating manner. Like little trees, the Ericas continue on into a new cycle from a new place.


Calluna vulgaris


Erica cinerea


Twisted stems of Calluna


Twisting in Erica tetralix

A spiral can be seen in the old wood of all 3 heathers. There have been various environmental and physiological explanations put forward to explain twisting in wood[7], but perhaps the most compelling account of living fluid movement comes from Theodor Schwenk's descriptions of the pattern of vortices within fluid movement. (Schwenk, 1965) Fluid movement can be observed where it has come to rest in the heather wood. It shows how in this respect they act like little trees.

Erica tetralix flowers only at the top of the stem, *E. cinerea* flowers mainly at the top but also from side shoots and *Calluna* flowers all the way up the stem. Thus flowering penetrates deeper into *Calluna* than in the two Ericas, *E. tetralix* least deeply. There's also a difference in the uprightness. *Erica tetralix* stoops at the top and at the other end of the spectrum *Calluna* is like a small steeple, quite upright. But the main difference is that the Ericas have the typical urn-shaped flowers, almost closed bowls, which face down, whereas *Calluna* has open flowers facing outwards, horizontally. Here the closed off nature of the Ericas is missing and *Calluna* interacts with the outside space.

Some of the South African Ericas are more tubular and show less of the rounded tendency but *Erica tetralix* and *E. cinerea* are both like little bladders with only a small opening at the top of the flower. This enclosure of air is an

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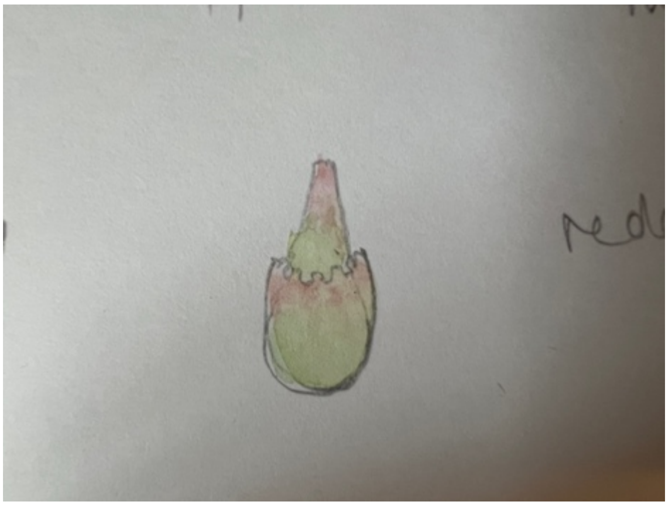
[7] Through the transport system water and minerals rise from roots to all branches. This uniform distribution of sap is indicated by the paths of vessels and tracheids, and has been proven experimentally by means of dyed sap injected into the base of stems or taken up by roots. *Spiral grain* is the helical form taken by xylem tissue in their growth along the tree. Trees receiving water only from roots at one side of the root collar nevertheless stay green and continue growing. Spiral grain in bark distributes food from each branch to other flanks of the stem and to most roots. Spiral-grained stems and branches bend and twist more when exposed to strong wind, in this way offering less wind resistance and being less likely to break. Through the bending and twisting, snow slides down from branches rather than breaking them, but the main function of spiral grain is the uniform distribution of supplies from each root to all branches, and from each branch to many roots. (Kubler, 1991).

animal gesture – as if gastrulation[8] is taking place, creating a dark, internal space. It only applies to the Ericas, not *Calluna*, which is a species on its own in this family. The way the Erica flowers enclose space is suggestive more of the ovary rather than the archetypical 'opening to the heavens' flower gesture. The flower form of the Ericaceae suggests the archetypal fruit quality, an encasing gesture which creates an internal space, closed off from the outer world. This is a receptive space – waiting for the arrival of pollen, something from outside, in order to create something new. In the carpels, the ovules begin their development into seed. This is a safe, protected space, which brings to mind the shelter provided for thrips by *Erica tetralix's* flower. The Erica flowers look like little fruits.

Calluna shows a different movement to the Ericas in opening fully and closing after flowering. Its spike and flowers face outwards to the horizon, not down to the earth, and remain like that in seed production. The Erica's flowers hang down in flowering then turn up to face the cosmos in seed formation.

Erica cinerea Flower



Erica cinerea Fruit

The archetypal seed quality is evident in the heathers too. This is something that fits the plant more as a whole and is supported by the plants' resistance to decay, their slow growth and lack of change, like suspended animation. The flowering impulse moving further down into the plant and the root not penetrating deep into the soil suggest a gesture of *contraction* i. e. the seed gesture of the archetypal plant, as does their condensing, drying, waiting nature. There is an apparent stasis which only relieves when they flower. However, a strong life force can be observed contained inside the plant, evident through it's 'springiness' and the abundant sweet liquid flow of nectar (especially in *Erica cinerea* and *Calluna vulgaris*) while flowering. It is safe inside while the exterior is battered by the harsh environment.

It is as if, from above, everything is pushed deeper into the plant.

The roots don't penetrate deeply into the earth and their spreading tendency reveals a desire to move outward, horizontally. Branches can take root where they touch the ground. They are dependent on a very specific mycorrhiza for their earth contact. It is not quite the radial character of the archetypal plant root but more suggestive of the leaf's planar quality, spreading out and opening to above and below.

There is a polarity between the top of the plant and the bottom, the roots. Above ground everything shrinks away from the environment, into itself, whereas below ground the opposite happens – the roots spread out near the surface and open themselves to the elements. These two opposing gestures are united by the circulating fluid, the sap.

[8] Gastrulation is defined as an early developmental process in which an embryo transforms from a one-dimensional layer of epithelial cells (blastula) and reorganizes into a multi-layered and multidimensional structure called the gastrula.

What is happening when the stem branches after flowering though – dividing, reminiscent of the calyx once again? The plant has entered a new phase and the generation process will start again.

Fire/warmth
Heathers have a close relationship with the warmth element. The dead wood is good tinder, being brittle and flammable. Earth meets warmth here, like in the landscape.

'Earth meeting warmth' could equally be in a desert however. What differentiates the two environments is the temperature, the cold of the moors versus the heat of the desert but also the moisture in the air that heathers must have as oppose to the dryness for desert plants, for instance cacti. Interestingly the substances heathers and cacti produce are opposite to the external conditions: cool, moist mucilage in cacti and warm, drying tannins in heathers. Tannins also provide the resistance to rot, helping plants survive the usual rots and moulds of the moor that promote decay.

Where the desert soil is sand, inert and lifeless, the moor and heathland is made up of decaying plant material. The surrounding water (bogs) is both anaerobic and full of sterile tannins.

The plants regenerate well after fire, hence the controlled burning used to manage the heaths and moors in order to provide fresh new growth for grazing. Underlying peat soil (made from partially decayed plant material including sphagnum moss and many other plant species like heather) is flammable and, if insufficiently wet, can slow-burn for years.

Also suggesting *inner warmth* is the plants' ability to survive such harsh weather conditions in such an exposed environment.

Planetary relationships

The Ericaceae could be said to show a Saturn influence.

> "Saturn as the (former) outer most planet of our solar system can be seen as the container for the other planetary influences. The far planets (Mars, Jupiter and Saturn) take the seed plants (angiosperms) beyond life processes and into independence."
>
> (Kranich, 1984)

Warmth permeates life processes leading to ripening of the fruit, and withering and drying out. The seeds that develop inside the fruit contain hardly any moisture and have dry, hard seedcoats.

Their self-protection, like a seed, does seem to be a fundamental quality of the heathers in the way they hunker down and contract away from the hostile environment, expressed so well in the urn-shaped Erica flowers and in the contracted needle-like leaves. However, the gesture of heathers doesn't go as far as the independence Kranich talks of.

It is however a quality of their landscape in that the moors represent the wild, the uncultivated which is cut off from civilisation. Yet they are self-sufficient. There's a feeling of self-reliance, self-preservation and self-possession, that they can wait for better conditions, ride the storm. It is as if they can keep their inner warmth safe under the most challenging conditions.

At the same time, they are a community, not isolated from each other but working in unity. In this sense they are completely open to the cosmos. There is a paradox between the single nodding bell flowers of an individual plant and the plants' expression in the landscape, another polarity. *Calluna*, not having the same flower form, does show a more open gesture.

Honey

The warmth appears to be reflected in the honey. Whilst the nectar appears clear and has little viscosity, the honey from both *Calluna* and *E. cinerea* have a rich amber colour. The dark colour means it has more minerals in it, showing a physicality in its warmth. It has an unusually high water content yet doesn't ferment where other honeys with the same percentage of water would. Again, we are aware of the fluid element in heathers.

Scottish heather honey (Calluna)

Bell heather honey (Erica cinerea)

It has a rare quality, thixotropy, meaning it appears as a gel or solid until stressed – moved or agitated - when it becomes liquid. The honey won't flow out of the combs until such a stress is applied. This is known as shear-thinning. To help clarify, the opposite quality, shear-thickening, can be seen in a semi-liquid cornflour and water mixture. Here when a stress is applied to the liquid it becomes hard. Both return to their former state, heather honey to solid or gel and cornflour to semi-liquid, when the force is no longer applied. Combs of *Calluna* honey can't be spun therefore but must be pressed to extract the honey.

It is said that if very pure (unadulterated by other plant nectar) *Calluna* honey may not crystallize at all (British Bee Journal April 4, 1912). Crystallisation is a hardening, becoming earthly, and to not crystallise is an indication of not just longevity but something eternal. (This is not connected to its thixotropic character as far as we know.)

A very few honeys have a similar thixotropic quality, notably grapefruit, *Abies* spp. and Manuka (*Leptospermum scoparium*). There are some similarities between *Abies* and Manuka and *Calluna*. They all like full sun and (mostly) an acidic soil and live in extreme conditions of cold and wet (firs) and sea winds (Manuka).

In *Abies* the leaves are evergreen needles, the type of contracted leaf form one might expect in a cold, dry environment, and show a similar lack of metamorphosis. Here the scent and aromatic oils (warmth) have penetrated into the leaves but there is no blossom. With *Calluna* the scent, characteristically of honey, is with the flower. Both have a mobile inner warmth life.

Manuka has small evergreen leaves with a sharp, pointed tip. The flowers, relatively larger than those of the heathers, open with 5 petals. *Calluna* and Manuka[9] have been well researched and out of all honey producing plants are particularly valued for their exceptional antibacterial and antimicrobial properties.

Grapefruit's position in this group is less obvious.

Landscape

The moor and heathlands can feel very different at different times of year and in different locations. Perhaps the essence of where heather grows is its openness to the heavens and to light, and the feeling of space.

It´s spreading habit along with this openness appear as a polarity to the plants' contraction in its form and size, away from outside space.

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[9] Manuka is a non-peroxide honey and displays significant antibacterial effects even when the hydrogen peroxide activity is blocked. Its mechanism may be related to the low pH level of honey and its high sugar content (high osmolarity) that is enough to hinder the growth of microbes. Medical grade honeys have potent *in vitro* bactericidal activity against antibiotic-resistant bacteria causing several life-threatening infections to humans. But, there is a large variation in the antimicrobial activity of some natural honeys, which is due to spatial and temporal variation in sources of nectar. (Mandal, 2011).

Lying on the heath one feels a sense of openness, an opening of the chest area and support from below. I spent an afternoon in Yorkshire lying on the moor. It was an overcast day but with closed eyes, there was such a strong sense of light I had to several times open my eyes to check whether the sun had come out. It had not.

In opposition however is the separation of the heath and moorland from the cultivated or so-called civilised world, the poor, acidic soil where no food can be cultivated and the heathen as outcast from a religious society. Rudolf Steiner talks of the heathens as being still in touch with the spiritual world, seeing spirit in all nature. When Christianity spread, those who did not change were 'excluded'. The moor and heathland are somewhere to go to escape society, isolated spaces where, paradoxically, man can renew his ability to feel connected. (See Appendix C)

At the heart of heathers is this polarity between contracted, condensed form and open, light landscape. They are a community, individually so small as to be hard to see well without a magnifying glass, but together carpeting entire mountainsides in purple.

Comparison

Heathers are quite difficult to read: the leaves have no real metamorphosis and the plants grow very slowly making their study a lengthy process. In order to gain a comparison, I chose to look at two bee plants from a different family, the Boraginaceae. Borage (*Borago officinalis*), a good honey bee plant and an annual, allowed me to observe the growth patterns more easily. The other member of the Boraginaceae family I chose was comfrey (*Symphytum officinale*), not a honey bee plant but popular with other bees, and a known healing plant.

Borago officianalis **Borage, Borretsch**

Habitat, height

Borage is an annual plant from North Africa and the Mediterranean and enjoys light sandy soils. It grows up to a metre tall. They self-seed prolifically.

Roots

The root is a fleshy tap root. As it is an annual, it only briefly connects with the earth and so develops to a certain, relatively small size. It can be very easily pulled up. There is no mycorrhiza growing with them.

Stems

Stems are fleshy, branched, ridged and hollow with silica hairs. Side shoots develop soon after the stem starts to sprout upwards. It twists slightly as it grows.

Leaves

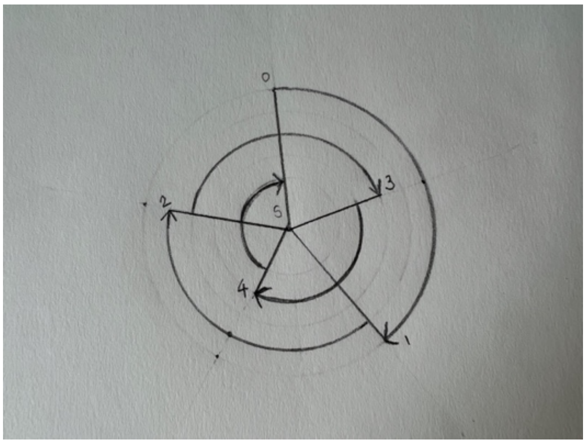
Borage begins its seasons' growth with fleshy cotyledons with a mid-line indentation.
The leaves form a tightly packed rosette to start with.
Each leaf is 'rugose' (raised) with raised white spots. The leaves point slightly upward (at an approx. 135° angle) and curl downwards at the tips.

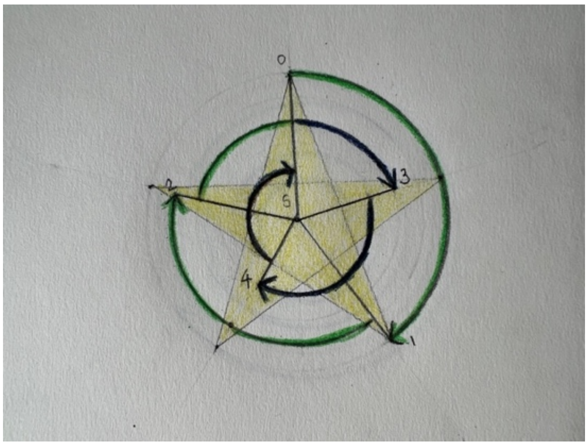
The leaves at the base of the plant are rounded with long petioles. On the flowering stems, the leaves become smaller and start to become pointed at the tip and finally the petiole disappears. Leaves on a flowering side shoot are also without a petiole (sessile). They are decurrent, meaning the edges extend downwards into the lower internode a little.

Borage leaves are covered with silica hairs giving them a rough, prickly feel. The family is known as Raublattgewächse (rough leaves) in German.

Phyllotaxy

The leaves spiral around the stem at an angle of 144°, so it takes 2 cycles to return to the starting point and 5 leaves.





<u>Leaf sequence</u>

<u>Calyx</u>

The calyx has 5 hairy sepals which alternate between the petals. They are fused at the base but the long sepals open freely. The buds begin to show at a very early stage, before the stem has started to elongate. At this stage they point upwards.

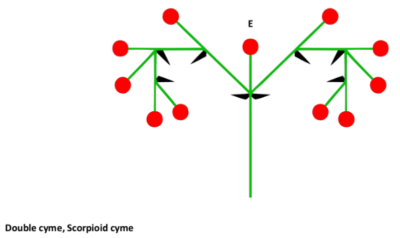
Just before flowering they hang down towards the earth and open with the flower. The tips point downwards and in while the petals' tip point up. They close after flowering and reopen to release the seeds. They have continued to grow between flowering and releasing the seed and remain open after the seed has fallen. The tips now turn up at the ends and point outward.

<u>Corolla</u>

The corolla has radial symmetry, like the calyx, and has 5 blue, fused petals. White scales or 'fornices' (belonging to the petals) stand in the throat of the corolla, surrounding the group of stamens. Buds grow in 'clusters' known as scorpioid cymes. The petals curve (clockwise) as they emerge from the bud.

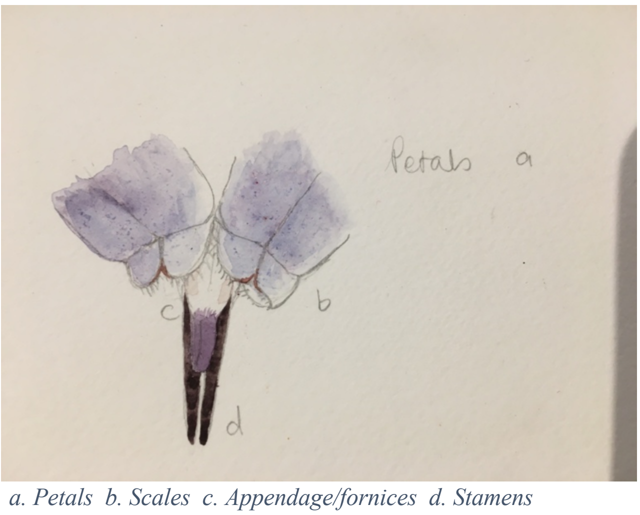
There's a rhythm to the unfurling of each cluster. The first to open is the *inward-most* bud. It rises up above the future buds on its pedicel (flower stalk), still facing towards the ground but less steeply, at a 45° angle approximately. As the flower ages the petals recurve. Each flower lasts about a day before the fused corolla and stamens fall to the ground. The flower stalk then falls again as the next bud from the outside starts to rise and open. The calyx then closes. It becomes clear later that flowering has alternated from left to right along the inflorescence and that the pedicels all come from the upper side of the flowering stem, leaving the underside smooth. All side shoots bear clusters of flowering buds like the main one at the centre of the plant.

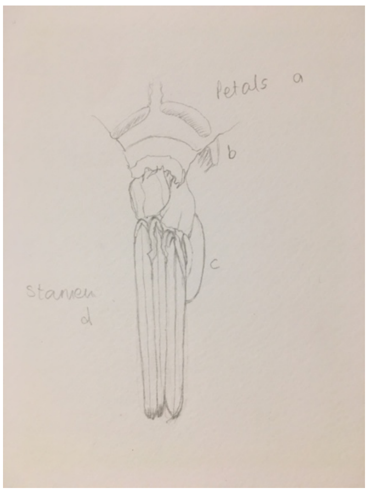
Buds emerge pink and when the petals unfold, turn blue. The staminal appendages also turn from red/pink to blue.



Double Scorpioid cyme. The flower E terminates the main shoot and opens first. While in bud, both branches of the inflorescence are more or less curved/coiled in a spiral.

There are typically 5 stamens that are attached to the corolla. Their base is enlarged and bears a long appendage. The black anthers form a tight cone around the style. They open with pores and the small, dry pollen grains fall into the tip of the cone. Trying to reach the nectar behind the white scales, bees cling to the appendage. Their weight opens the cone and the pollen falls down on them. Pollen grains have 3 pores. Pollen is released before the style is mature.





a. Petals b. Scales c. Appendage/fornices d. Stamens

Research by Stawiarz et al showed that Borage is popular with a range of pollinators: honey bees 29.5% (*Apis mellifera*), bumble bees 22.2% (*Bombus* spp.), other bee species 21.4%, flies 18.5% (*Diptera* spp.) and other insects 8.4%. They also noted that honey bees chose nectar more readily than pollen whereas bumble bees favoured pollen over nectar. (Stawiarz, 2020)

<u>Fruit/seeds</u>

Flowers have a superior ovary and the fruit is a schizocarp: it is bilocular, each locule being divided by a false septum into 2 parts, thus forming a 4 parted ovary, each containing one brownish/black nutlet. Seeds are large and contain a high proportion of oil. They have a lipid-rich attachment, the elaiosome, which attracts ants.

Chemistry

Constituents

Borage contains tannins, silicic acid, mucilages and flavonoids. (Hauschka, n.d.) There is also a small amount of pyrrolizidine alkaloids. (Fleischhauer, 2013)

Taste:

The leaves taste of cucumber and in German the herb is also called Gurkenkraut = cucumber herb, a reference to its use in pickling cucumbers.

Colour

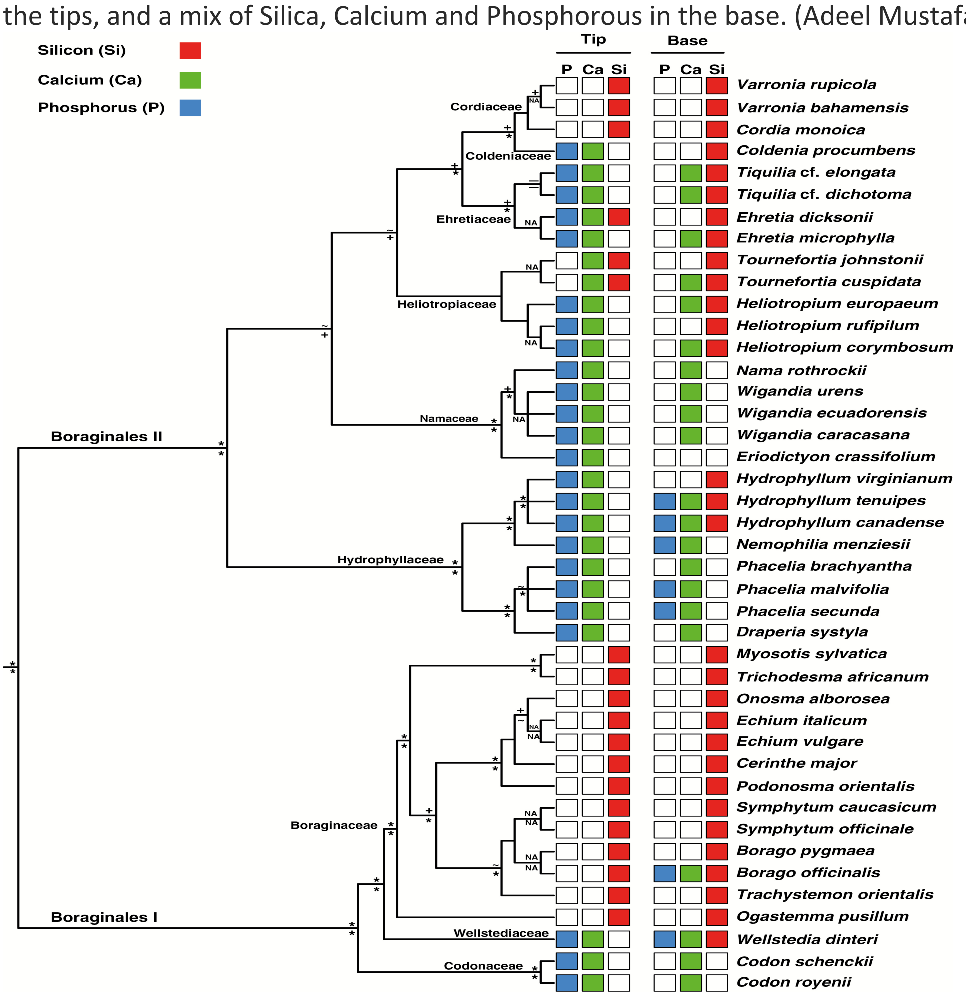
The petals and sepals turn from pink to blue because the acidity of the cell sap changes from acid to alkaline as it loses its vitality with age. Anthocyanins from the Greek anthos (flower) and cyanos (blue) are the water-soluble pigments that respond to a change in acidity. In this case it doesn't appear to be related to pollination. (Wiki, n.d.)

Oil

Borage oil extracted from the seeds has a high gamma linoleic acid (GLA) content. It is a main source of GLA along with Evening Primrose oil. Here we see evidence of the warmth element in the seed.

Silica

The Boraginales have mineralized trichomes (hairs), often a combination of Silica and Calcium. Borage has silica in the tips, and a mix of Silica, Calcium and Phosphorous in the base. (Adeel Mustafa, 2018).



"Silicic acid is present in plants and is found mostly in the tissues that make up the cell walls. Here, also, substance is deposited from the living cell, in conjunction with being moved outward during the building of the cell walls." (Romunde, 2001).

Grasses and horsetails contain a high concentration of silicic acid in their cell walls. The high silica content parallels the tendency towards a linear structure, opposing gravity, a direction away from earth towards the heavens. (Julius, 2000).

The hairs in Borage are at the outside of the plant, showing the same tendency to move outwards as silica in human hair and nails. The main stem begins upright but loses its ability to maintain an upright position and flops to the side. The whole plant glows with the light of the silica hairs.

Silica in solution can take up a considerable amount of water and become colloidal, mucilaginous – between solid and fluid – responsive to form-giving impulses, shaping and reshaping impulses of life. On the other hand, silica is always trying to rid itself again of water, aiming towards the highest and most definitive form, rock crystal.

At the periphery the silica principle appears in radiant form (hairs) revealing something of its crystalline, mineral nature. **Silica evokes peripheral growth in all organs**. Hairs, barbs on fruit don't drop off when flowering is over and may grow into wings or similar structure although not in the case of Borage. (Pelikan, 2000)

Nectar and honey

The honey is light in colour and taste. Its high fructose content means it is slow to crystallize.

Pelikan gives some interesting thoughts about nectar from this family:

"Thanks to the plastic and fluid element, the flowers produce plenty of nectar and the members of the borage family are important bee plants. Their nectar is tinged with silica processes and therefore suits bee nature particularly well. The marvellous craftsmanship used in shaping the hexagonal cells which are to receive the honey they have converted from nectar, arises from a sensitive awareness of the impulses towards hexagonal form inherent in silica, a mineral which crystallizes in hexagonal form. The Borage plant passes this impulse on to their nectar, just as the nectar of plants of the mint family [Labiatae] give their nectar something of their warmth quality and thus meet the *warmth* which is part of the bee nature."

(Pelikan, 2000) *Translation adapted in part by Ruth Mandera*

Pelikan talks of an impulse passed from plants to bees via their nectar – warmth in the case of the Labiatae (today known as Lamiaceae) and silica processes in Borage[10]. What might be the impulse passed along by the heathers, particularly *Calluna vulgaris*, such a favourite of honey bees?

[10] Of course honey bees don't rely on Borage for their instinct to make hexagonal cells but does this impulse help them?

***Symphytum officinale*. Comfrey. Beinwell.**

Symphytum officianale showing one of the two cymes

Symphytum officianale

Identification

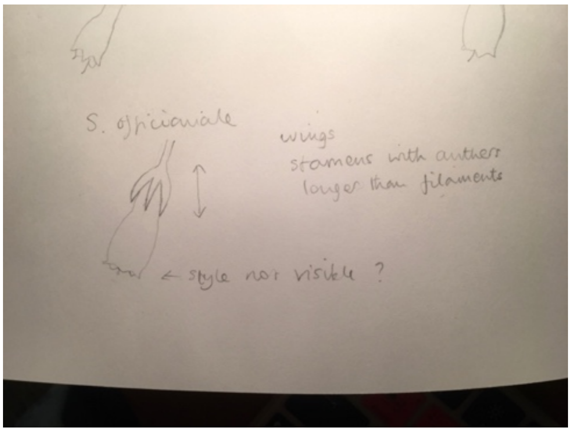
It can be difficult to distinguish *S. officinale* and *S. asperum* in the UK as they have hybridised and subsequently introgressed (back-crossed) with native populations.

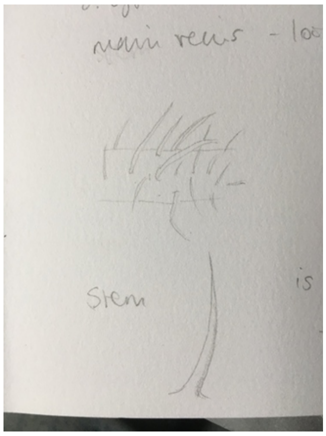
Not only that but the flower colour can be unstable and highly variable in many of the comfreys (particularly the hybrids). According to the online *web id guides* "It has been noted that the flower colour on an individual plant can be different from year to year and can vary as the season progresses. In the creeping species, the flower colour can even be different on shoots that originate from the same root system." (Crewe, 2020).

The creamy yellow-flowered form is stated by Hooker to be *Symphytum officinale* proper, and the purple flowered he considered a variety and named it *S. officinale*, var. *patens*. The botanist Sibthorpe makes a definite species of it under the name *patens*.

S. officinale
Variable in height, up to 1.5m
Longer calyx, wings, stamens with anthers longer than filaments, *style not visible*

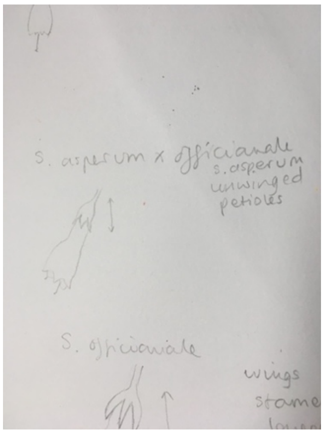
> ***Subsp. officinale***
> **Variable creamy-white (*var. ochroleucum*) to carmine (*var. purpureum*). Can be cream, carmine or mixed, striped.**

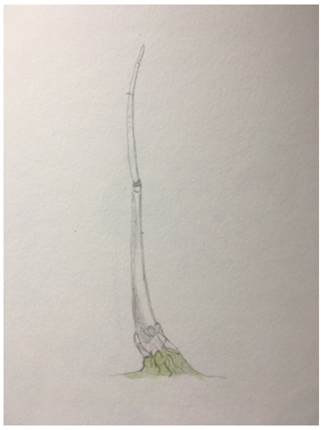




Stem strongly winged all the way from leaf axil to the next
Calyx teeth long (4mm), pointed, narrow
Long, down-pointing, tapering hairs
Cream, yellow or red-purple (Rose, 1981).
Flowering time: May to Sept (Pelikan, 2000).

S. asperum x officinale
Taller, up to 1.8m.
Short calyx, unwinged stem, style visible



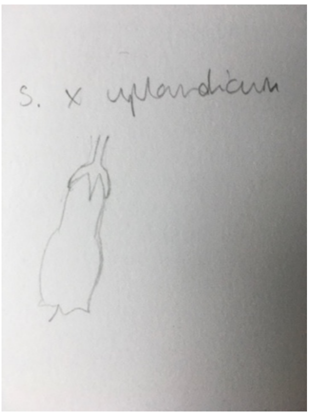



***S. asperum* (prickly comfrey)**
Red in bud becoming sky blue
The hairs are made up of separate parts which break off when touched and make it prickly.
Flowering time: (not in Rose) May - July

***S. x uplandicum* (Russian comfrey)**
Symphytum × *uplandicum* (*S. asperum* × *S. officinale*, synonym: *S. peregrinum*) (Rose says *S. officinale* x *S. grandiflorum)*

Hybrids form a range of intermediates. Leaves generally lack the broad winged leaves of *S. officinale* but are never heart shaped with a petiole as in *S. asperum*.
Short wings down stems (Rose, 1981)
Calyx longer than *S. asperum* but still short.
Flower colour varies from reddish-purple to violet. Often spreads vegetatively.
Flowering time: June- August

Laurence Hills, founder of the Henry Doubleday Research Association, first developed the sterile hybrid, Bocking 14, much loved by organic gardeners for producing copious amounts of leaf for compost and mulch.



Symphytum officinale

Habitat

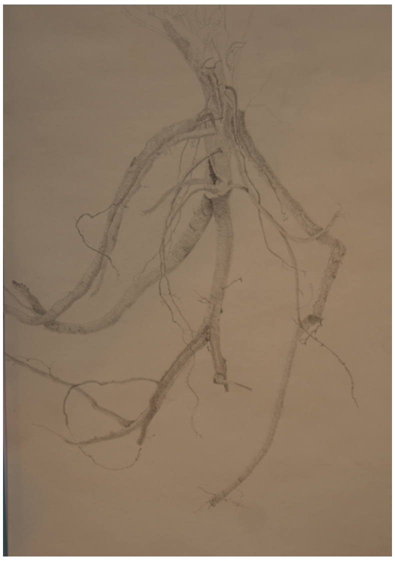
Symphytum likes water meadows, damp places, roadsides and waste ground.

Height and Spread

It is a perennial found in Europe and West Asia and grows up to approximately a metre tall.

Roots

The root is a deep tap root, with many different roots coming from a dense centre which is built on year by year.
It is dark brown on the outside with a fleshy, white inside which is slimy, mucilaginous to the touch. The inside soon turns brown on exposure to air. They contain pyrrolizidine alkaloids. They live with the most common 'vesicular-arbuscular' mycorrhiza.



Comfrey root

<u>Stems</u>
Like Borage it has fleshy, hollow stems covered with silica hairs. They are moist, stringy and never become woody. (Observation: in early August flowering stems were not hollow but fibrous to the core. There had been a drought.)

The leaves of the flowering shoots are not separated from the internodes and grow together so that the stem becomes 'winged', more strongly than in Borage.

Side shoots develop soon after the main stem starts to sprout upwards. The base of the new shoots have a purple tinge to them.

<u>Leaves</u>
Comfrey's undivided leaves form a loose rosette at the start of the season. They are alternate, stalked, rounded and wider at the base, and pointed at the tip.

The leaves are flat, with white spots like Borage and also covered in rough hairs.

Metamorphosis

The leaves at the base of the plant are broad with long petioles. Leaves at the base of a flowering side shoot are sessile, not separated from the internode. They grow together so that the stem becomes winged. On the flowering stems the leaves become smaller and more pointed at the tip.

Pairs of upper leaves are strongly suggestive of a bird's wings with the budding cyme hanging beneath them.

<u>Calyx</u>

The calyx has five hairy sepals, which are fused at the base.

Corolla

The corolla has radial symmetry and has 5 fused petals which form a tube, widening as it grows beyond the calyx and coming inwards at the tip. Each fused petal then splits apart slightly and curls up.

Like in Borage, the petals form whitish 'throat scales' (Schlundschuppen), here hidden inside the tube. The flower cluster is also a double scorpioid cyme (cincinnus), see page 39.

Unlike in Borage the flower buds don't appear until the main stem has risen. In *Symphytum,* the cluster is more tightly packed together so the two spirals are clearly visible. Flower E opens first, then both spirals bloom approximately symmetrically. The tips, at the centre of the coils, are last to flower. The inflorescence hangs down.

Colour change from small bud to open flower

Scorpioid cymes held apart

As with Borage, the colour changes from bud to fully open blossom. In the striped variety of *S. officinale*, the bud is a more intense colour and more of a single colour than striped. As it opens, the colour fades and the stripes appear. As there is variety in the colours of this subspecies it could change from deep carmine to a carmine and cream stripe, from pink to pale pink stripe with cream, or show little change in the case of cream.

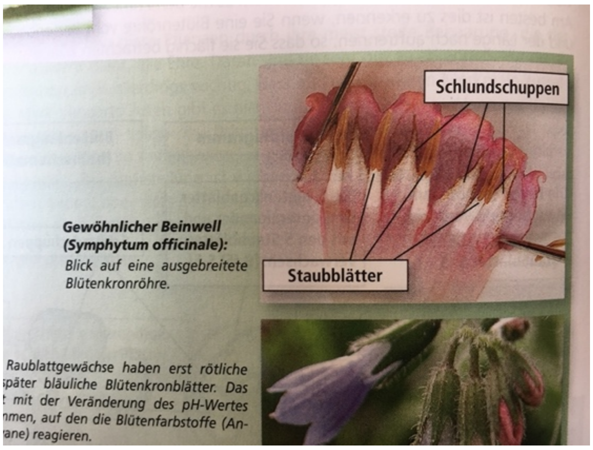
Single flower detaching from calyx *Petal turning brown at the end and falling*

The corolla quickly turns brown and falls to the ground, revealing the long white pistils, a Boraginaceae trait that is most extreme in Phacelia.

Phacelia tanacetifolia

There are typically 5 stamens that are attached to the corolla alternating with the 'throat scales' of the petals. The throat scales form a cone that covers the shorter stamens. The anthers open with pores and dry pollen falls into the tip of the cone. To get to the nectar insects need a long tongue/proboscis (longer than 11 mm) which they force between the throat scales. The cone opens and the pollen falls out. Often bees bite a hole at the base of the corolla, an easier way to reach the nectar.

Observation: bumble bees have a deep, throaty buzz, low notes, steady whereas the honey bee has a higher tone, more pace, activity, urgency/excitement even.



The plant flowers continually from May to mid-summer when it starts to break down. It renews vegetative growth after flowering with even larger leaves. Sometimes it flowers again.

<u>Fruit/seeds</u>
Flowers have a superior ovary. The fruit is a schizocarp, it is bilocular, but divided by false septum in a 4 parted ovary, each containing one brownish/black nutlet. The seeds also have an elaiosome attached to attract ants.

Flowers turning brown

Nutlets, immature and mature

Seed developing within the fruit

<u>Chemistry</u>
The main constituents are mucilage (root), allantoin (root), pyrrolizidine alkaloids (root), saponins and a little tannin.

Allantoin is a cell proliferent and helps wounds, burns and ulcers (internal and external) to heal. It is a degradation product of nucleic acids and is produced from uric acid. It is named after the allantois, found as an embryonic excretory organ in animals. After birth nitrogenous waste is excreted in animals in the urine as allantoin. In humans and other higher animals, the metabolic pathway for conversion of uric acid to allantoin is not present, so uric acid is excreted.

The more toxic pyrrolizidine alkaloids (PAs)[11] are not found in *S. officinale.* There is a running controversy over the safety of comfrey root and leaves (leaves contain fewer PAs than the roots). *S. officinale* contains very little, if any, but *S. asperum* does contain a toxic PA, echimidine. The difficulty comes in identifying which plant you have, as they hybridise so readily and the PA does appear in hybrids. Herbalists would argue that the amount is still too small to cause liver damage unless taken in excessive amounts but authorities often take a more cautious approach.

The therapeutic properties of comfrey are based on its anti-inflammatory and analgesic effects. Comfrey also stimulates granulation and tissue regeneration, and supports callus formation.

It's common British name 'Knitbone' reveals its ability to help set broken bones and fractures. "…yea, it is said to be so powerful to consolidate and knit together, that if they be boiled with dissevered pieces of flesh in a pot, it will join them to grow together again." (Culpeper, 1653)
I did attempt this and two pieces (out of seven) did stick together - a bit!

<u>Nutrients</u>
Comfrey makes a good feed for plants, being rich in nitrogen and potassium. It a good compost activator because it has a low carbon to nitrogen ratio and breaks down quickly. The deep taproot mines minerals from the earth. Its close connection to animal urine through allantoin may add to the nitrogen.

<u>Silica</u>
Whereas Borage has silica in the tips, and a mix of silica, calcium and phosphorous in the base, *Symphytum* has just silica (Adeel Mustafa, 2018). *Symphytum* doesn't 'glow' with light like Borage, the hairs are more modest. The plant has more of a 'base', a strong root and much leaf growth at the ground before the stem reaches up. It too will topple over but it doesn't rock the whole plant as with Borage, the base remains stable.

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[11] Whether or not a PA is potentially toxic depends on one tiny molecular feature. If the molecule has a double bond between C1 and C2 in the necine ring system (i.e., if it is 1,2-unsaturated), it can release toxic pyrroles as it is metabolized in the hepatocytes (liver cells). If it has a single bond in that position, it is completely harmless (these types are known as platynecine PA). Among the 1,2-unsaturated PA, the cyclic diesters (also called macrocyclic diesters or simply macrocyclic esters) are considered to be the most toxic subtypes; the open-chain diesters are of intermediate toxicity; and the monoesters are the least toxic forms. **Herbs of the Boraginaceae family (e.g., *Symphytum*, *Borago*, *Pulmonaria*) contain only monoesters and open-chain diesters,** while the macrocyclic diesters are characteristic of some genera of the Asteraceae family (e.g., *Senecio* spp.). Some Asteraceae (e.g., *Echinacea* spp., *Calendula officinalis*) only contain harmless platynecine PA. (Ganora, Alkaloids IV Pyrrolizidines)

Colour
Like other Boraginaceae there is a change of colour between bud and flower and they can fade from a dark, intense to a paler, washed-out colour. The stripes on *Symphytum officinale* in the petal are a variation of this theme.

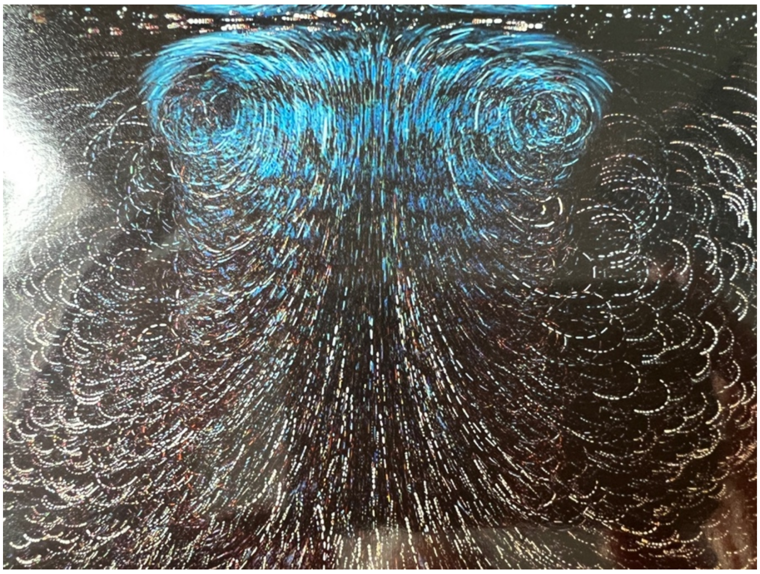
The colour changes show that the chemical processes in the water element are active in the flowering region, usually the domain of light and air.

Roots
"White is a colour associated with bone-healing, as in the white roots of true Solomon's seal, comfrey, black cohosh, and boneset. Sometimes there is a black covering over the white roots, but these are all bone-healers in one way or another." (Wood, 2016).

'Involvement with the silica process always gives the plant a special relationship to light. The plastic, watery element which is part of the plant type relates to a preference for damp sites. They want light, sufficient warmth and moisture. The healing properties of the family are largely based on the silica process peculiar to them…'
'Silica has an obvious relationship to light metabolism and form processes. In colloidal form it is able to assume the protean character of a fluid, though it aims for the highest definition of form in crystals…' (Pelikan, 2000).

Stem
In a plant with such an affinity for the water element, a hollow stem is a surprise. This indicates the air element, or astral, has penetrated deeply into Symphytum.

Gesture. Whole plant: Sense of a fountain, streaming up and cascading back down. This happens not just at the top but seeps out at the sides. It is as if it runs in a continuous cycle, streaming up through the centre, dividing and falling and streaming up again. It reminds me of a mushroom vortex seen in water.



Mushroom vortex. Wirbelbewegung *Foto: Andreas Wilkens*

Durch beleuchtete Partikel im Wasser werden Bewegungsbahnen des Ringwirbels und seiner Umgebung sichtbar. The movement of the ringvortex and its environment made visible through lit particles in water.
Photomontage aus 12 Ausnahmen. Photo montage of 12 stills.
Institut für Strömungwissenschaften Herrischried

Mushroom vortex made by paddle

Other Boraginaceae have a similar upstreaming, dividing and falling but not the same continuous cycle as Comfrey. They seem more at rest after the downwards movement.

The recurving of the Borage petals is suggestive of wings. It's as if a five-winged bird was taking off. *Symphytum* shows a similar gesture but in the topmost *leaves* rather than the petals! This two-winged gesture feels animal, bird-like – the wings up and the head down (in comfrey). In both the movement is one of lifting off rather than gliding or flying.

<u>*Meditation*</u>
Heard the mantra: Building up, breaking down… building up, breaking down etc

This lifting off gesture seems at odds with the circling motion of the vortex, hinted at in the Comfrey flower spirals. It is as if the leaves are striving for something higher while the flowers have already started to return to earth. In Borage the lift is greater, the gesture visible in the petals rather than the leaves as in Comfrey, and the spiral in Borage is less apparent, more spread out and diffuse. The upwards and outwards striving meeting the circling down and inwards gives such a feeling of movement. It fits with the polarity of building up and breaking down and the repeating rhythm of the mantra.

EXACT SENSORIAL IMAGINATION

Imaginative transformation from Symphytum to Calluna

An imaginative transformation helps us to reach the sphere of the living, acting life-forces. To *experience* the life processes of *Calluna* we have to imagine a *Symphytum* plant, as clearly and exactly as possible and then *we* metamorphose each of *Symphytum*'s organs into each of *Calluna*'s organs, trying to *feel* the living forces by doing it. And vice versa: to experience the creative forces in *Symphytum*, we imagine a *Calluna* plant and transform each organ into the corresponding *Symphytum* organ.
We chose to compare *Symphytum* with *Calluna* because the difference is so extreme.

Symphytum	***Calluna***
Roots	
Root very succulent, tap root with thick lateral roots – more cosmic	Dry (outer), inner - sap Branched – more earthy
Solid mass, largely separate from environment (chemistry – water)	Thin and wiry Many tiny rootlets enmeshed in surrounding soil – division, merging into environment
Vesicular-arbuscular mycorrhiza	Ericoid mycorrhiza
Dark brown/ black outside and white inside turning brown on exposure to air	Tan brown Not reactive to air
Leaves	
Deciduous – ephemeral, fleeting, Alternating, spiral up the stem	Evergreen – lasting for several years, 2 per node: opposite-decussate Initially tightly packed together
Leaf underside	
Hairs only on veins	Single vein running up centre
Top leaves	
Feels flimsier	More solid 3D shape
Flexible	Inflexible, fixed
At the top of the stem, the petiole shrinks and the leaf is closer to stem. Leaf and internode grow together: winged stem	All are pressed close to stem – no change
Change from lower leaves to top - mainly in size	Very little change in form or size
Dark green/no red	Lighter green/red blush
Dying: Turn yellow, brown then to a black slime	Turn brown but remain on plant – can be difficult to see if a plant is dead!
Easily dying, but easy regeneration	Longevity, resilience
Wing-like, suggesting movement	Still, whorls
	2 per node, balanced
Taste	
Vegetative	Astringent
Mouth feel – rough	Dry
Hairs	
Soft hairs becoming harder, pointed, glassy hairs with tip as the plant grows	Few, sometimes no fine, downy hairs
Protection from silica at extremity of the plant	Normal role of silica in cell walls

Living movement	
Expansive	**Constricted. ♄**
Floppy (hippy!)	**Rigid ♄**
Loose	**Fixed ♄**
Going out **Metamorphosis**	**Staying in** **Almost no metamorphosis**
Open to environment	**Protected from environment ♄**
Mobility	**Static**
Living and dying and regeneration	**Opposite – less 'living and dying', more static**
Flat, thin, 2D	**Solid, fat, 3D**
Stem	
Ridged, winged	Smooth, rounded
Hollow, air-space inside	No air inside
Fibrous	Dense, concentrated
Easily broken although stringy at the ridges	Flexible, wiry, springy and hard to break. Tougher
Covered in glassy hairs giving white haze appearance	Small hairs give the appearance of a white bloom
	Scales with hairs at rims (nothing comparable)
Tall and rangy - temporary and precarious	Upright and stable, steady, measured
Petiole - decurrent (extends down the stem). Makes it very stem-like but it does extend away from the stem at an angle	
Spring growth	
At base strong connection to the earth with many shoots springing from the root - rush of renewal	Comes from further up in the plant, taking off from where it left the year before – continuing slowly, less dramatic
Fleshy green, doesn't brown until dying – contrast between living and dying is strong	Duller green or brown as ages – less contrast, can be difficult to tell if the plant is alive or dead
Slightly softer as young plant but doesn't harden much with age	Flexible and springy in youth, hard and brittle as ages
Nothing woody, remain moist and fleshy	Stems become woody and twisted with the years and there's a sense that they have lost their life force. They are brittle, dry and prone to break easily. Also flammable
Flowering stem	
Shoots up after a lot of substance was produced at the base	Condensed, initially tightly packed together
Much space between each node	Do enlongate as the plant grows, stretch out a little, on a much smaller scale
Stems from side shoots	Starts growing from where it left off last year ie the division after flowering
A final division of the flower bearing axes leads to two parallel coils	Grows straight, vertically. Divides *after* flowering
Buds are rounded	Conical

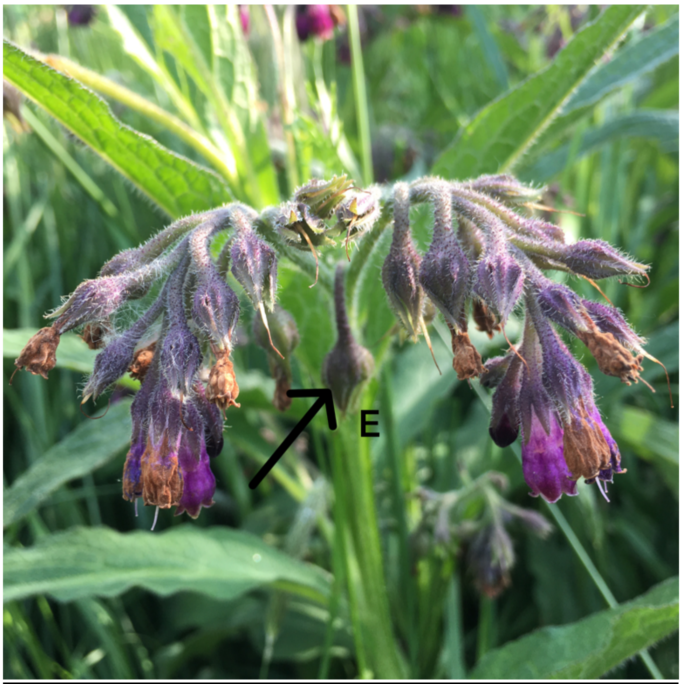
A bit out of control, instability	Opposite –stability, feeling of the 'bigger picture', not in the whirl of activity but still, in the centre and less affected by what is going on around it. ♄
After second division curls inwards	Buds/flowers face outwards away from the centre of the plant
Always in and out of balance as if it has to work hard to be there. Expenditure of energy	Always compact, not expansive, even in flower, self-contained. Conservation of energy
The return to earth is after division and via flowering - facing down and the petals drop to the ground Surrender	Branches are top heavy because of division each year up the stem. They return to the earth where they can root. Calluna resists the return to earth, goes as far as the branch touching the soil but grows upwards from there – strong sense of upward growth although not large in size. Persistence
Like a fountain – coming up, meeting something that sends it falling back – turning around, to earth but the bud that opens is initially at the top then the longer pedicel lets it fall and face the earth – so much more movement	Hardly any movement. A little lax at the top sometimes. No downward pull – unimpeded upwards and then buds to the side, but continues growing after flowering. Then divides
Living movement	
Feeling of movement – fountain surging up then dividing and falling down	**Slow, steady upward movement, then division and slow fall down, then steady return upward**
Division in axes – into 2 and 2 again before flowering	**Division after flowering, radiating, approximating a whorl**
The flowering axes bear flowers on the upper side and alternate left and right giving a rhythmic feel. **Reversing the division in imagination means the flowering side would become the inside.**	**Flowers on the outside of the stem**
More movement, space	**More compact, restricted, static**
Filling, expansion	**Contracted**
Exuberance	**Restraint**
Life force and change	**Preservation**
Dips down to earth but immediately continues upward growth **Continuous**	**Return to earth is complete: Pause!**
Flowers	
Calyx	
	A bract with spurs attached directly to stem. From this a short pedicel appears, then a whorl of 4 scale leaves circles the base of the bud/flower (see photo below). Reddish colour. Much more differentiation of parts than in comfrey. Instead of a single green calyx and corolla there is a lower bract, second bract – a set of scale-like leaves, waxy pink calyx and then corolla.
Starts in a tight, rounded ball	Starts wrapped up in a cone shape and opens to shallow bowl-like shape

Fused at base	Separate sepals
Hairy, green	More petal-like, scaly/waxy texture, pink
Divided into 5 lobes. I imagine 5-star man (Leonardo da Vinci)	Divided into 4, a cross – vertical and horizontal only.
Alternating with each (fused) petal	Alternate with petals at 90°
Pedicel, slim and delicate arching downwards	Chunky bracts connecting it to the stem, sometimes small petiole. Stolid
Tips open as flower matures then close when corolla falls	Opens with flower and closes around petals when pollinated
After flowering	
Expansion in size	Will close around the petals which decay inside but not completely enclosed as the sepals are separate at the tips. No expansion, more economical
More rounded, ridged	Spherical but with indentation where sepals meet in the centre
Begin with reddish tinge and turn green as mature	Turn from pink to pale brown and take on a paperish texture
Close and then open to release seeds	Don't open to release seed, less movement
Living movement	
Protective at fruit/seed development stage	**Protective around the petals**
Will let go	**Will stay – calyx remains closed even when seeds are mature**
Opening restricted at base	**Opening fully**
	Drying
Symmetry and rhythm in the divisions	**Rhythm but not symmetry, more alternating**
	Note – interesting that the 3D space appears in the leaf in Calluna but not the flower (as it is not a bell, which would be 3D although it encloses empty not solid space).
Corolla	
Petals fused, 5 lobes	Fused at the base, divided into 4 tips, alternate with sepals, more open
2 stages in the tubular corolla – widens into a bell shape at the base, narrowing at the very bottom and turning up at the ends	Each petal is gently bowl-shaped, curiously **shorter** as the sepals!
Colours – carmine, but fade as they bloom, going into a muddy mauve.	Pink, reflective quality
Nothing everlasting about it – quick to turn brown, even before it leaves the plant, and to decay	Petals turn brown within the closed calyx and decay, calyx turns light brown
Corona of 5 throat scales in the throat protecting the nectar	No scales
Pistil	
Long white pistil protrudes and remains (as in Phacelia)	Shorter brown/purple pistil. Sturdier
Style – white, sometimes with purple tip	Purple/brown
Stigma - white	Pink
Stamens	
Attached to inside of petals, alternating with petals, on the same radius as sepals,	In the centre – bee has to circle the stamens to brush against the pollen

facing inwards – bee is coated with pollen on entering the corolla tube	
White filament, light brown anther	Dark brown, vertical anthers with white spurs at their base; filaments white covering the ovary, not fused Sturdier, darker, less ethereal
No movement	Tips are tightly bunched together at the centre then open out as flower matures. Movement outwards, opening
Pollen colour	
White	Taupe, brown, dark brown
Flowering	
Before calyx lots of movement, division then curls up into a coil	Before calyx little movement
When the coil has unfurled it is as if it has done its expanding and dividing and will now returning to the earth.	
Colour change from dark to light as the buds in the coil develop – a deep, rich carmine to cream or stripes of cream and faded carmine (both are types of *S. officinale*). As if the colour gets washed out and dulls as it grows	Pink sepals and petals with a reflective, light quality Appear to shine, shimmer
Coil unfurls as flowering begins, moves horizontally	Continues straight – just smaller at the top
After unfurling at the end of flowering it is no longer the expressive one – not much movement, not much opening but facing down, has peaked already	Opens to horizontal – feeling of it emanating on and on, as if you can't see the horizon. Space around. Peaking now
Living movement	
Hanging face down, to the earth	**Open to the world, facing outwards like little eyes looking out, curious but not open like a daisy showing all to the world!**
	First steps – tentative. Doesn't want to draw attention to *individual* self although it does en masse
In spiral – mysterious, the beauty is here in *Symphytum* rather than the open flowers (although the hanging flowers are quite pretty). **Has reached the apex and will soon start to decline (petals turning brown before they fall)** **Dangling flower heads that have finished, inside the closed calyx which is now swelling with the developing fruits, look like dead turkeys, no longer beautiful!**	**Shining – this is its time! Being seen, recognised, but again, en masse rather than individual.** **Much younger, fresher, purer** **Secure – more self containment; held, not so free to the surrounding space (wind etc), less movement. Not so animal.**
Wavering – dependent on outside conditions	**Sturdier – less dependent on environment**
Active, movement (at division stage)	**Stillness – simplicity**
Dulling, almost dirty ♄	**Lightening, brightening - stars**
Deadening, death comes early	**Enlivening, death delayed**
Flowers are concentrated in coils at the end of the axis/shoot, without any leaves	Flowers are concentrated at the top of the shoot but always accompanied by leaves

Fruits & Seeds	
Stem straightens horizontally out of its coil as the flowers fall and the calyces close	Calyces stay on the plant for months, slowly shrinking and finally appear as a tiny, chalky ball as if mummified Transformation: A sort of active v passive decline
Turn yellow, then brown and dry, crispy	Also dry out and shrink but more slowly
Infructescences face down like the flowers	Capsules face outwards, away from the centre of the plant
Carpels	
Schizocarp - bilocular but divided by false septum with 2 per locule.	Hairy capsule, dehisces 4 lobes with many small seeds in each
4 brownish/black nutlets, one seed inside every nutlet. Shiny.	
Living movement	
Letting go, shedding	**Not letting go**
Closing but then expanding in size	**Encased but not entirely – gaps leaving it open to the environment, like a little cage**
Wrapping, 'hugged'	**Similar feeling of wrapped up**
Internal rest period while fruits and seeds are developing	**Same**
Opens to shed fruits, 'big reveal'	**Stays closed – seeds fall through the gaps, no drama**
After flowering	
Everything falls to earth but new shoots emerge later in the season. Leaves are even larger and sometimes it will flower again.	Capsules remain on the plant and new vegetative growth begins immediately above. The stem then divides in a radiating manner.
Living movement	
Circular movement: beginning again from base	**Continuing on, not 'finished' but a new cycle has started, part of the whole. Each time raised a little (Steigerung).**

In *Calluna* the main axis, the stem, is carrying the flowers. In *Symphytum* the main axis ends with flower E and *two new axes* evolve, with new characteristics.



Symphytum during fruit formation with E marking the end of the main axis

Landscape Comparison

Symphytum	Heather
Darker, trees and other plants in the surroundings	Light, few other plants and no trees around
	Space, feeling of stretching out
Not somewhere, you usually walk into. Often difficult to get to, by water.	Sense of aloneness when walking on the moors yet the plants grow in community (Northern hemisphere) – a polarity
Less open, because of surroundings vegetation - other plants, shrubs, trees	Open, 'big sky'
Green	Not very green, often looks brown from a distance
Disordered, messy	Ordered, neat mounds
Mud – rotting, in with the water	Bog – preserving qualities, a separateness from the water
Affected by water: If dry it flags/flops	Less affected by water: If dry doesn't change much although not keen to grow in pots!
In tune with the environment: watery plant in watery setting, and able to bring air into this setting via its hollow stems	Polarity with the environment: open environment - expansion; plant is held back – contraction. So it lives between the polarities, uniting them.
Symphytum can crop up in various locations, it doesn't define the landscape around it	A very distinctive landscape – heathland, moors, bog

Summary

Symphytum grows by water, often water meadows but also in ditches and damp waste areas. It can appear 'scrubby', not orderly or the sort of look for a cultivated garden. It is a plant in sync with its environment. The watery element shows in the form of the leaves.

The heathers' form doesn't reflect their place in the same way – the leaf form shows neither the air element (division, like the Umbellifers) yet it grows in a light, open, airy space; nor do the leaves show the watery element (spreading, undivided leaves) yet it is mostly found in damp places. Perhaps the cold overrides these elements and so we see the contraction in the leaves, just as in conifers.

Honey/nectar comparison

Brother Adam, beekeeper from Bustfastleigh Abbey, described heather honey as "…red brown, like the water of the peat bog. A gift of Nature carrying the tang of moorland air."

Borage is predominantly visited by honey bees although other bees do visit. I observed *Calluna* in southern England covered in honey bees. In Scotland sightings of honey bees are much rarer and the heath bumble bee (*Bombus jonellus*) is more commonly seen except in calm, sunny weather when honey bees can sometimes be seen. It is hard to believe that the relatively sparse numbers of heath bumble bees can pollinate all the heather in Scotland. One sees crane flies (Tipula lateralis) but these are not pollinators. Hagerup suggested that thrips play an important role in pollination but that the heathers can also self-pollinate. In the Faroe Islands there are no other insect pollinators. (Hagerup, 1953).

Erica cinerea is also visited by honey bees as well as other bees and is a big honey producer. The honey is not thixotropic.

Erica tetralix which grows in damper conditions is less often visited by honey bees. Hagerup – suggests the corolla is too long for the honeybee tongue to reach, however I have certainly seen honeybees on the flowers. (Hagerup, 1953).

Comfrey is not a honey bee plant but for bees with a longer tongue to reach the deep nectar – or robbers, who pierce the base of the corolla and drink for free!

Borage honey	**Calluna honey**
Light in colour	Dark in colour
Beige, pale yellow	Reddish/orange to dark amber
Thin	Thick
Clear	More opaque
Liquid that crystallizes slowly	Thixotropic (appears solid until stirred, then becomes liquid) – can't spin the honey from the frames, has to be pressed
	Ling honey – higher water content so more prone to fermentation? This is debatable – the % of water allowed in ling honey is greater than for other honeys because it *doesn't* ferment so easily, because the gel traps the water. But the water content *is* higher.
	Slightly bitter, tangy, pungent, smoky, mildly sweet taste that persists for a long time. strong distinctive woody, warm, floral, fresh fruit aroma reminiscent of heather flowers

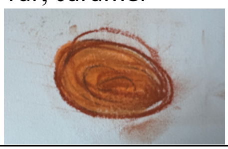
Borage honey

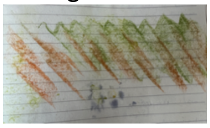
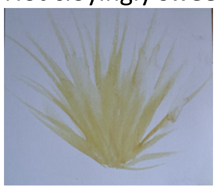
Heather honey (Calluna)

Heather honey (Calluna)

Honey tastings

Initials refer to Sarah Cowell (SC 1 & 2), Jane Cowell (JC), James Meldau (JM) and Mike Galbraith (MG)

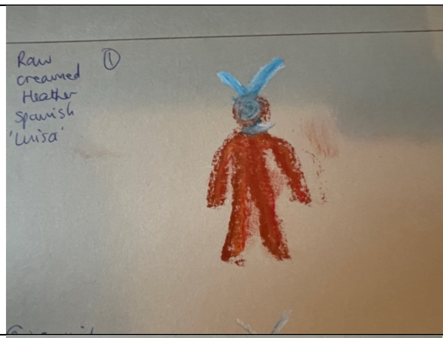
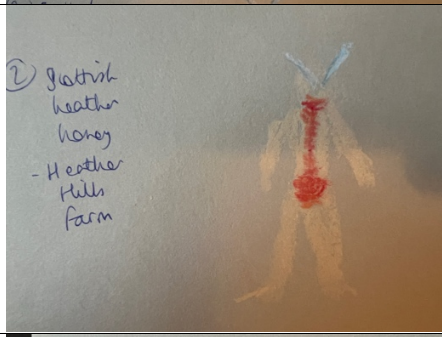
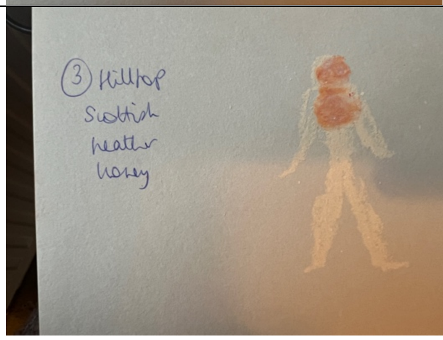
	SC 2	JC	JM	MG	SC 1
Bruyère French Calluna	Smoky Acrid Bitter Honey smell 	Earthy smell Not strong Minted?? Tastes like it smells Dessicated leaves 	Not much smell – just honey Sweet Not much acidity	Scented Flowery Fruity Citrus	Slightly honey (Calluna) smell Clear, amber-red Brown Smooth, even Smoky, bit acrid in back of throat Wood fire smoke – pine? Orange-fruity increases saliva Tar, caramel 
Bell heather UK	Smoky Acrid at back of tongue Red treacle flavour 	Scent: deep, warm, slightly rotten, earthy, lilies, damp wood, decay Bitter Sweet Burnt Beer More smell than taste 	Slight medicinal edge Sweet Aromatic	Layered Complex Comforting Restful	Clear – reddish Smokey, not strong Not cloying or harsh Quite smooth Wood smoke Tobacco, resinous Think of peat fires Something vegetative, hyssop?/medicinal 
Brezo Spanish Calluna	Sweet Mild Tang at the end Bit bitter back of throat Creamy	New clean wood Sawn Appley? Fruity Figs	Sweet – overriding taste Faintly medicinal	Dark Deep Veiled	Dark, shiny, thick Not strong smelling nor sweet smelling, not like honey Smooth

	Burnt caramel Toffee 	Slight toffee 			Hint of sweet at back of throat Mild Fudgy Hint of bitter at back of throat Harsh Slight lemon tang 
Calluna raw UK	Smell hits you - honey! Bit watery taste Slight bitterness Bit vegetative 	Scent: strong initially. Like Bell but not as much lily/moldiness. More incense/paler Quite pale Difficult to get depth Tantalising hints vanish 	Sweet Lack distinctiveness but enjoyable Not medicinal	Big Fat Over-perfumed Cloying	Smell! Clearly Calluna honey Caramel Activating taste buds Rich Fruit – more orangey than lemon Not too sweet Light Not cloyingly sweet 

Honey meditations

The meditations were not to concentrate on the taste but pay attention to subtle awareness of what was felt in the body and beyond the physical body, in the subtle bodies. Although there were definitely differences between the honeys, what was more interesting perhaps was the similarity between them. There was a sense of smoothing, melting and warmth, as if the subtle bodies were being smoothed or gently melted together. It was a harmonious feeling.

Borage	Relaxing, warm, melting feeling as if subtle bodies able to join Spicy feeling in mouth Calming Sense of head, bit woolly Smooth, gentle, settling Aware of surface of body Head and third eye, crown Warmth body	

Raw creamed heather (Spanish)	Very caramel – bitter, dark, warming Smooth Movement around head and throat, especially left side Not sure what movement exactly but upward and dividing, V-shape Aware of liver at one point Body melting, head feels a bit hard, rigid	
Raw Scottish heather* honey (Heather HIlls Farm)	Warming on inside – almost burning at throat as it goes down (not in actual throat) All the way down to womb. Felt healing, inner warmth Even softening head. Similar movement to 1 but that wasn't the emphasis	
Scottish heather*[12] honey (Hilltop)	Slower warmth spreading down from head Very slowly – the speed of spread seems to echo the actual speed of pouring/movement This was the slowest, then 2 then 1, which was quite runny Warmth in throat area almost burning again, and into chest area – mainly aware of it on the surface, like a 'rub' Aware of my hands - tingling	

More honey tastings and meditations - see Appendix B

Imaginative transformation from *Symphytum* to *Borage*

Symphytum	***Borage***
Roots	
Deep and spreading	Single tap root
Root very succulent and mucilaginous (tap root – cosmic)	Less moist
Dark brown/ black outside and white inside turning brown on exposure to air	Pale brown
Solid mass, largely separate from environment	Thinner, smaller. Shallow, easily pulled.
Lives for many years	Lives for only one year
Living movement	
Strong, solid but moist	**Shrinking, contracting, weakening, drying**
Anchoring in earth	**Less deep, less secure**
Stable	**Instability**

[12] * Scottish heather is *Calluna vulgaris*

Leaves	
Bigger, long, broad near lamina base, thin at end, metamorphosis	More rounded at tip and can be indented, can bend down at tip, metamorphosis
Looser, several shoots develop along the rootstock	Bunched, in a rosette
Flatter, slight undulation at edges	Increasing undulation in later leaves
Darker green	Pale to mid green, redness in petiole
Initially upward then move to more horizontal position	Begin horizontally and move upwards
Decay and turn black then new leaves come	Become yellow and then brown and desiccated as plant ages
Taste	
Vegetative	Cucumber, fresher
Hairs	
Soft hairs becoming harder, pointed, glassy hairs with tip as the plant grows	Harder, rougher
Living movement	
Expansive but sucked to a point at the tip	**Pulled up and down rather than toward tip**
Flat, thin, 2D	**More towards 3D with undulations**
Living and dying and regeneration	**Full of substance to start with but fades away**
Darker	**Lighter**
Floppier	**Maintains structure, stiffer, especially in hairs**
Mineral hair less well developed and reflect less light	**Mineral hairs more developed and reflect light more – as if the silica has come further up into, and out of, the plant**
Stem	
	Fleshy, almost translucent when young
Hollow, air-space inside	Even more space inside
Fibrous	Also fibrous
Covered in glassy hairs giving white haze appearance	Much more 'light-filled'
Tall and rangy	More so
Leaves alternate; but can spiral up stem too	Leaves at precise angles – 5 leaves in 2 cycles of 360°, regular
Petiole – decurrrent, it extends down the stem. Makes it very stem-like but it does extend at an angle away from the stem	Less winged
Flowering stem	
Shoots up after a lot of substance producing at the base	Shoots up early
Stems from side shoots	Same
Divides at apex of stem then each side divides again on the opposite axis (at 180°). A final division of that stem leads to two parallel coils	Buds appear before the flowering stem shoots upwards
Buds are rounded	More pointed
Flowering early in the year - April	Later but quickly in relation to plant growth, similar
After second division inflorescence curls inwards	Coil is less evident but is there

Living movement	
Feeling of movement leading to uprightness but because of pulling and pressing. They feel in balance and so there is a stability although not rigid at all, flowing.	**Feeling of instability.** **Bunching in lower area.**
Flowers	
Calyx	
Starts in a tight, rounded ball	More oval
Hairy, vary from green to purple. Darker red/purple at mid vein	More hairy – distinction between the white, reflective hairs and the dark red/purple calyx leaf. Also darker red/purple mid vein
Coiled	Looser but follow the same pattern in opening
Living movement	
Sense of balance in the coil	**Less in balance, as if pulled up and out of itself**
Corolla	
Petals totally fused, 5 lobes	Only fused at base
2 parts to the tubular corolla – straight to start with then widens into a bell shape at the base, narrowing at the very bottom and turning up at the ends	Very different form. 5 distinct petals that twist upwards (recurve) while the stamens point downwards
Colours – carmine, but fade as they bloom, going into a muddy mauve.	Pink to blue. Much stronger colour
Nothing everlasting about it – quick to turn brown, even before it leaves the plant, and to decay	Falls quickly, usually after a day. Colour doesn't fade
Corona of 5 scales in the throat	White scales, at the base of each petal, and staminal appendages which also change colour, from pink to darker blue/purple
Pistil	
Long white pistil protrudes and remains (as in Phacelia)	Sometimes visible just beyond stamens
Style – white, sometimes with purple tip	Pink towards tip, white towards base
Stigma - white	Paler pink/beige
Stamens	
Attached to inside of petals, opposite to sepals, facing inwards – bee is coated with pollen on entering the corolla tube	Stamens fully visible, beginning close together making a point at the centre, facing down. As the petals are ready to fall, the stamens open out.
White filament, light brown anther	Dark brown/purple
Living movement	
Fused, enclosing space	**Open but facing down, towards the earth**
Static, content	**Movement, as if pulled upwards, wants to fly**
Fruit development	
Stem straightens horizontally out of its coil as the flowers fall and the calyces close	Very similar rhythm but looser coil and more movement in the opening and closing
Living movement	

Like turkey heads when ripening, then expanding	**More movement. Caterpillar-like - the movement of each new flower – rising on its pedicel to the top then falling again, a wave.**
Sense of the job being finished but it will soon start again	**As if will keep going, forever producing a new flower bud. Striving for the unattainable, to be animal?**

Meditation on the gesture

The same gesture can be seen in the leaves at the top of the flowering stem in Symphytum as in Borage's flower. In Symphytum it feels graceful, in balance. The lift of the leaves is balanced with the descending flower coil. In Borage it feels more uncomfortable – as if the flower is trying to escape the confines of the earth but can't and is forced to turn back, as if the light is trapped.

There's something very rhythmical about where the upward motion meets the downward motion in Symphytum. The mushroom vortex seems to fit well – an upward thrust that meets resistance and curls back upon itself.

"A spiral is a circle linearized".

Summary – *Symphytum* and *Borage*

"In the ether body, everything is in a living, flowing state of interpenetration, whereas in the physical body, distinctly separate parts are present." (Steiner, An Outline of Esoteric Science, 1925) GA13 *First published in German, 1910*

Symphytum has great affinity with the water element. The roots are succulent and mucilaginous, the flowers change colour but more as if diluted than the pink to blue, typical of the Boraginaceae, related to acidity. The leaf is planar and entire, the whole plant is plastic and continually in "movement". It is a master at creating substance and shows itself to have a strong life force, not just in a positive sense but also in its ability to decay quickly, an indication that the air element has penetrated deeply into it. It has a strong vegetative ability to regenerate. It is as if the water and air element are in balance.

Borage shows movement in several respects: the raising of the flower stalk when it is flowering followed by a retreat to below the stem; the petal's recurve (and twist), the flowering stem leaning over late in the season when the seeds have been released, the whole plant unable to support itself any longer. Almost like a wave, rearing up before coming crashing down to earth. It brings to mind the tomato plant (*Solanum lycopersicum*) with its similar flowers and inability to be upright. (Although whereas Borage stops growing with the first inflorescence the tomato keeps on and on.) Borage manages to be upright to a point but despite the presence of silica in the plant, unlike horsetail or a grass, it cannot maintain it. The silica has been pushed further out in Borage and *Symphytum*, into the hairs at the periphery, whereas horsetail and grasses keep it within, in the cell walls where it gives them structure. As if the mineral is moving out of its element, earth, and into the realm of light and air – but not as far as the flower region.

Comparison of Boraginaceae and Heathers

In contrast to the Boraginaceae, just as with the leaf metamorphosis, there is very little change in the *Erica* flowers from bud to open flower. The enclosed inner space remains. They face down when first open but turn upwards the cosmos after pollination. Borage and comfrey also face down to earth with their flowers but remain facing the earth to produce and release their seed. It is as if they only briefly touch the higher realms before turning back to earth.

Calluna shows more movement than the Ericas by opening fully in flower and closing after flowering. Here the closed off nature of the Ericas is missing and *Calluna* interacts with the outside space.
Comfrey bears more resemblance to the Ericas in its flower form with its tubular nature and only opening at the end. Borage opens fully and even recurves like a *Solanum* plant. It closes after pollination and opens again to release the seed.

Whereas heather flowers stay on the plant and resist decomposition, both borage and comfrey flowers fall from the plant as soon as they have been pollinated and quickly discolour and decompose. Comfrey shows this tendency to breakdown most strongly. The corollas often show browning when still on the plant.

Here lies a fundamental difference between the two families. The high tannin content facilitates the heathers' resistance to decay and their permanence. *Symphytum* on the other hand is continually breaking down (catabolism) and building up (anabolism), a wholly metabolic activity. Comfrey is known for both composting (breaks down quickly) and as a remedy to help heal broken bones (building up). Heathers show the polar opposite quality of preservation.

CONCLUSION

In the introduction, I said that what I hoped to do was to understand the plants' qualities at a deeper level in order to be able to understand better the effect of a particular honey on bee well-being and to have a better idea of how to investigate further.

Has this study of the heathers helped us discover more about a quality or qualities the plants might pass on to the bees?

Is there a relationship between the ability to resist decay in heathers and the ability of bees to overwinter successfully? The resilience of heather in a hostile environment echoes the colony's attempt to seal itself off from the outside through the winter and maintain its warmth. The warm dark hive interior matches the Saturn seed gesture. I would suggest that the ability to 'resist' the outer world is reflected in the anti-bacterial and anti-microbial properties of *Calluna* honey.

Equally the heathers' seed gesture brings to mind the overwinter clustering, a contraction opposite to the expansion of mid-summer when the bees extend the hive's reach by a few miles. The summer expansion is much more closely related to the Borage gesture.

Polarity in heathers
The contrast between the individual plants' held back nature and their expression on the landscape is stark. The inward-looking, protective and closed nature of individual heathers is polar opposite to their spreading habit, covering huge areas and growing no more than half a metre high, an open, airy, light gesture. These polarities bring to mind the Yin-Yang image.

There's also the polarity between southern and northern hemispheres – many species each covering only a small area in the south and few species covering large areas in the north, a feature they hold in common with conifers. In Europe, they make up a community, each small plant merging with its neighbours and carpeting the land whereas in southern Africa they are more individual.
Is there a relationship here between the bees as individuals and as a social organism?

In his book 'Bees' Rudolf Steiner describes how if one looked at an artery through a sufficiently large magnifying glass one would see that it no longer looks like blood but like little dots resembling small animals. " …you will see a great similarity between it and a horde of bees swarming about." He is making the point that the human being is a whole, not a collection of the small components within. "… the beehive isn't simply what you would call a collection of an undetermined number of bees, but rather a complete whole, a complete being." (Steiner, Bees, 1923) Lecture: 5 Dec 1923, GA 351

The difference between the Ericas and *Calluna*'s open flower form is intriguing. The seed gesture is most strongly shown in the Erica flowers yet *Calluna* shares the qualities of permanence and being held back. If the fruit and seed gesture qualities are pushed more deeply into the Ericas, is *Calluna* less affected? The feeling I have is that *Calluna* manages to resist an inward pressure and to turn around to shine its light back out into the 'heathen' landscape.

Another question is whether honey bees would naturally have *Calluna* and *Erica cinerea* as their diet. In the more extreme environments where heather would not need to be managed to exist it is more likely that hardy bees such as *Bombus jonellus* and the tiny thrips would be the main pollinators. It is curious that a plant reputed to help bees overwinter is not naturally available to them in many instances. They do seem to have developed a particular relationship with man.

The issue of man intervening to ensure a habitat can exist is very topical. 'Wilding' is being experimented with and we are learning a lot about what happens when nature is left to her own devices. This study has given me pause for thought about this practice, not that it isn't a good thing to do as we learn so much about how nature rebalances but that it may not be the only path to a good relationship with nature. Once we understand more deeply, we will be able to become consciously involved. Perhaps wilding is more like going back to the heathen way – back in touch but not yet with conscious awareness.

Calluna, with its scent of honey, seems to produce an almost archetypal honey of deep, warm colours and suspension from life and death (not crystallising). Borage gives a very different picture. The whole plant is suffused with light and shows an affinity with the sun. As an annual it develops with the increasing sun and fades along with it. In the bees' annual cycle this corresponds to a build-up of brood peaking at the summer solstice, before declining numbers into the late summer and autumn. One can see why borage is such a favourite with bees, there's a feeling of the plant and life cycle of the bees being in tune.

It may seem like common sense that plants offer the right food for bees and other insects at the right time of year but by getting to know the plants more deeply the relationship has become a little clearer. It makes one question the way scientific studies such as those carried out by the Royal Horticultural Society conclude that pollen and nectar from any source (native or non-native) is equally good for pollinators. They may all be 'good for' but maybe in different ways. Older studies that equated nectar with carbohydrate for fuel and concluded that there was therefore no difference between feeding candy or their honey to bees, miss a more qualitative understanding. There are subtle qualities that may not be able to be measured in terms of their effect on bee health but by becoming more aware of the connection between the plant, the bee and the planetary rhythms maybe we can gain a deeper understanding of why diversity is important and what each plant offers to the bees.

Further research
It would be interesting to study other bee plants and consider their relationship to the bee life cycle and the wider cosmos. For example:

- how do other plants (such as clover) that peak at the summer solstice differ from Borage?
- likewise how does a winter plant like ivy differ from *Calluna*?
- what of other plants popular with bees like blackberry?
- and how is it different where climates allow for different honey bee life cycles ie in India or Africa where there is no winter and bees may reproduce 3 or more times a year?

Relating forage plants to honey bees demands, of course, a greater understanding of the bees. This would be the next relationship to explore. I think knowing the plants better leads naturally to a desire to know more deeply their place between earth and cosmos.

In addition to the differences in the species of Ericaceae and their distribution between northern and southern hemispheres there is something curious in the West and East with respect to honey and bees. Rhododendron in the east and Kalmia (mountain laurel) in the United States both in the in Ericaceae family, produce toxic honeys, a rare phenomenon. They are potentially toxic to both bees and humans. Rhododendrons produce what's known as 'Mad honey'.

It would be interesting to research the other thixotropic honeys – grapefruit, Manuka and *Abies* spp. and compare to them *Calluna*.

And finally the spirals in the Boraginaceae and other spirals in plants such as the Hermes staff of the leaf pattern around the stem and the living movement of fluid perhaps using projective geometry is an appealing avenue of exploration.

There may be more questions arising from my study than I have answered but I have learnt so much from my journey with the heathers, borage and comfrey and Goethean science.

APPENDIX A

Summaries of scientific studies of the honey bee diet and health

<u>Supplementary feeds ie sucrose or HFCS (high fructose corn starch) as honey substitutes and various pollen substitutes</u>

Comparison of Productivity of Colonies of Honey Bees, *Apis mellifera*, Supplemented with Sucrose or High Fructose Corn Syrup (Sammataro, 2013)

Honey bee colony feeding trials were conducted to determine whether differential effects of carbohydrate feeding (sucrose syrup (SS) vs. high fructose corn syrup, or HFCS) could be measured between colonies fed exclusively on these syrups. In one experiment, there was a significant difference in mean wax production between the treatment groups and a significant interaction between time and treatment for the colonies confined in a flight arena. On average, the colonies supplied with SS built 7916.7 cm(2) ± 1015.25 cm(2) honeycomb, while the colonies supplied with HFCS built 4571.63 cm(2) ± 786.45 cm(2). The mean mass of bees supplied with HFCS was 4.65 kg (± 0.97 kg), while those supplied with sucrose had a mean of 8.27 kg (± 1.26). There was no significant difference between treatment groups in terms of brood rearing. Differences in brood production were complicated due to possible nutritional deficiencies experienced by both treatment groups. In the second experiment, colonies supplemented with SS through the winter months at a remote field site exhibited increased spring brood production when compared to colonies fed with HFCS. The differences in adult bee populations were significant, having an overall average of 10.0 ± 1.3 frames of bees fed the sucrose syrup between November 2008 and April 2009, compared to 7.5 ± 1.6 frames of bees fed exclusively on HFCS. For commercial queen beekeepers, feeding the right supplementary carbohydrates could be especially important, given the findings of this study.

<u>Investigation identified secondary metabolites that were peculiar to certain plant</u>

Di Marco

Botanical influence on phenolic profile and antioxidant level of Italian honeys

Honeybees directly transfer plant compounds from nectar into honey. Each plant species possesses a specific metabolic profile, the amount and the typology of plant molecules that may be detected in honey vary according to their botanical origin. Aim of the present work was the spectrophotometrical determination of concentration ranges of simple phenols and flavonoids in 460 several Italian monofloral honeys, in order to individuate specific intervals of plant metabolites for each typology of honey. Moreover, an LC–MS analysis was performed to determine amount of various secondary metabolites in the samples, with the purpose to use them as potential molecular markers in support to honey melissopalynological classification. As plant molecules have a strong reducing power, the antioxidant activity of the honeys was evaluated by two antiradical assays, DPPH and FRAP. The free radical scavenging effect of each monofloral group was correlated to the concentration of simple phenols and flavonoids, with the aim to deduce the existence of possible relationships between these parameters. In conclusion, dark honeys (*Castanea sativa*, honeydew, *Erica* sp. and *Eucalyptus* sp.) appeared to be the richest in secondary metabolites and, consequently, showed higher antioxidant activity. However, all analysed monofloral honeys showed to be good sources of antioxidants.

(Marco, 2018)

<u>Diversity</u>

Brodschneider

Nutrition and health in honey bees

Adequate nutrition supports the development of healthy honey bee colonies. We give an overview of the nutritional demands of honey bee workers at three levels: (1) colony nutrition with the possibility of supplementation of carbohydrates and proteins; (2) adult nutrition and (3) larval nutrition. Larvae are especially dependant on protein and brood production is strongly affected by shortages of this nutrient. The number of larvae reared may be reduced to maintain the quality of remaining offspring. The quality of developing workers also suffers under conditions of larval starvation, leading to slightly affected workers. Larval starvation, alone or in combination with other stressors, can weaken colonies. The potential of different diets to meet nutritional requirements or to improve survival or brood production is outlined. We discuss nutrition-related risks to honey bee colonies such as starvation, monocultures, genetically modified crops and pesticides in pollen and nectar. (Brodschneider, 2010)

Implicit in Brodschneider and Crailsheim's question about supplementary feeding is the assumption that nutritional deficit *can* be replaced with supplementary feeding.

Secondary metabolites in floral nectar reduce parasite infections in bumblebees

Richardson

"There are numerous reports of bees poisoned by secondary metabolites in nectar and pollen, and bees can incur reproductive costs when they consume these compounds. **However, limited evidence demonstrates that secondary metabolites can benefit bees, for example by enhancing memory and foraging efficiency, reducing parasite infection and controlling pathogenic fungi.** The potential therefore exists for plant secondary metabolites to play an important role in mediating tritrophic interactions among plants, pollinators and parasites, but how costs and benefits of chemical consumption affect bee survival and reproduction remains relatively unexplored." (Richardson, 2015)

Influence of Pollen Nutrition on Honey Bee Health: Do Pollen Quality and Diversity Matter?

Pasquale

Honey bee colonies are highly dependent upon the availability of floral resources from which they get the nutrients (notably pollen) necessary to their development and survival. However, foraging areas are currently affected by the intensification of agriculture and landscape alteration. Bees are therefore confronted to disparities in time and space of floral resource abundance, type and diversity, which might provide inadequate nutrition and endanger colonies. The beneficial influence of pollen availability on bee health is well-established but whether quality and diversity of pollen diets can modify bee health remains largely unknown. We therefore tested the influence of pollen diet quality (different monofloral pollens) and diversity (polyfloral pollen diet) on the physiology of young nurse bees, which have a distinct nutritional physiology (e.g. hypopharyngeal gland development and *vitellogenin* level), and on the tolerance to the microsporidian parasite *Nosema ceranae* by measuring bee survival and the activity of different enzymes potentially involved in bee health and defense response (glutathione-S-transferase (detoxification), phenoloxidase (immunity) and alkaline phosphatase (metabolism)). We found that both nurse bee physiology and the tolerance to the parasite were affected by pollen quality. Pollen diet diversity had no effect on the nurse bee physiology and the survival of healthy bees. However, when parasitized, bees fed with the polyfloral blend lived longer than bees fed with monofloral pollens, excepted for the protein-richest monofloral pollen. Furthermore, the survival was positively correlated to alkaline phosphatase activity in healthy bees and to phenoloxydase activities in infected bees. Our results support the idea that both the quality and diversity (in a specific context) of pollen can shape bee physiology and might help to better understand the influence of agriculture and land-use intensification on bee nutrition and health.

(Pasquale, 2013)

Diversity of Honey Stores

Silvio Erler

Honeybee colonies offer an excellent environment for microbial pathogen development. The highest virulent, colony killing, bacterial agents are Paenibacillus larvae causing American foulbrood (AFB), and European foulbrood (EFB) associated bacteria. Besides the innate immune defense, honeybees evolved behavioral defenses to combat infections. Foraging of antimicrobial plant compounds plays a key role for this "social immunity" behavior. Secondary plant metabolites in floral nectar are known for their antimicrobial effects. Yet, these compounds are highly plant specific, and the effects on bee health will depend on the floral origin of the honey produced. As worker bees not only feed themselves, but also the larvae and other colony members, honey is a prime candidate acting as self-medication agent in honeybee colonies to prevent or decrease infections. Here, we test eight AFB and EFB bacterial strains and the growth inhibitory activity of three honey types. Using a high-throughput cell growth assay, we show that all honeys have high growth inhibitory activity and the two monofloral honeys appeared to be strain specific. The specificity of the monofloral honeys and the strong antimicrobial potential of the polyfloral honey suggest that the diversity of honeys in the honey stores of a colony may be highly adaptive for its "social immunity" against the highly diverse suite of pathogens encountered in nature. This ecological diversity may therefore operate similar to the well-known effects of host genetic variance in the arms race between host and parasite.

(Erler, Diversity of honey stores and their impact on pathogenic bacteria of the honeybee, Apis mellifera, 2014)

In-hive pharmacy

Silvio Erler

Introduction: Honeybee's self-produced gland secretions and foraged hive products should chiefly facilitate medication and sanitation of the colony. *Apis mellifera* developed several behavioral defense strategies known as

‘social immunity'. The main nutrients of a bee colony, honey and pollen, contain many plant compounds that prevent microparasite and pathogen growth, and inhibit viral replication. Secondary plant metabolites in nectar are especially well known for their antibiotic effects. These highly plant specific compounds are used by the individual worker honeybee and are transmitted via trophallaxis to the whole colony. Here I will show cases of prophylactic and therapeutic bee product application, enhancing honeybee health. Methods: 1. Using a high-throughput cell growth assay and 8 different American and European foulbrood associated bacteria strains, we tested several honeys for their bacterial growth inhibitory activity. 2. Therapeutic self-medication was discovered by using nurse honeybees, infected with the microsporidian gut parasite *Nosema ceranae*, and various types of honey in a simultaneous choice assay. Results/Conclusion: Notably, monofloral honeys appeared to be strain specific in their antibacterial activity. The specificity of the monofloral honeys, and the strong antimicrobial potential of the polyfloral honey suggests that qualitative variance in the honey stores may be highly adaptive for ‘social immunity'. *N. ceranae*-infected workers preferred honeys with the highest antibiotic activity that also reduced the microsporidian infection. Since worker bees not only feed themselves but also larvae and other colony members, honey is a prime candidate acting as a self-medication agent in honeybee colonies to prevent or decrease infections.
(Erler, Pharmacy bee hive — use of natural drugs to increase pollinator health, 2016)

Pathogen-associated self-medication behavior in the honeybee *Apis mellifera*
Gherman
Honeybees, *Apis mellifera*, have several prophylactic disease defense strategies, including the foraging of antibiotic, antifungal, and antiviral compounds of plant products. Hence, honey and pollen contain many compounds that prevent fungal and bacterial growth and inhibit viral replication. Since these compounds are also fed to the larvae by nurse bees, they play a central role for colony health inside the hive. Here, we show that honeybee nurse bees, infected with the microsporidian gut parasite *Nosema ceranae*, show different preferences for various types of honeys in a simultaneous choice test. Infected workers preferred honeys with a higher antibiotic activity that reduced the microsporidian infection after the consumption of the honey. Since nurse bees feed not only the larvae but also other colony members, this behaviour might be a highly adaptive form of therapeutic medication at both the individual and the colony level.

Flagellum Removal by a Nectar Metabolite Inhibits Infectivity of a Bumblebee Parasite
Koch
Koch et al. elucidate the first mechanism that explains how nectar secondary metabolites reduce infection by the common bumblebee parasite *Crithidia bombi*; exposure to callunene, a megastigmene from heather nectar, results in the loss of the parasite flagellum, leading to reduced infectivity. (Koch, 2019)

APPENDIX B

Honey Tastings

People were asked to rate the qualities in column 1 between 1 and 5 ie light and heavy 1 being lightest and 5 heaviest

Qualities	Bruyère French Calluna	Bell heather UK	Brezo Spanish Calluna	Calluna raw UK
Light – heavy	2,2	3,4	5,2	5,1
Happy - sad	2,3	2,4	3,2	4,3
Hard – soft	4,4	4,4	2,4	3,3
Warm – cold	4,3	4,3	1,2	2,3
Bright - dark	2,4	4,4	5,4	4,4
– dead	1,4	3,4	1,2	4,3
Pleasant – pungent	2,5	3,4	2,2	2,3
At ease - uneasy	2,5	2,4	2,2	3,2
Alert – sleepy	1,1	4,3	3,4	4,3
Invigorated – weakened	1,2	3,3	2,3	4,4
Thin - fat	2,1	4,3	4,3	5,2

MG, SC
Yellow highlights exact match
Green highlights within 1

More Boraginaceae honey meditations

	SC	
Echium	Much movement, hard to grasp Sense of the being – feathery, thread-like Lighter Colours, immediately warmth in whole body then lighter Pale green/blue, white – threads Delightful Aware of chest area, high heart Mostly by head and third eye Streaming across eyes to start with and something like a dandelion seed moving up, white threads Then more, different movements	
Myosotis	Twisting movement – like a diagram of a muscle, from top to bottom Darker warmth Very much in body as if it was warm and cosy and comfortable Did find myself thinking – ideas High heart area Face – as if smoothing tension there, sinuses Quick pain in gall bladder? Grounding, earthy, went straight to base chakra	
Phacelia	Dark, nothing happened Not pleasant Taste too, harsh at back of throat, crunchy crystals As if outside me Eventually some movement coming up and down, still dark but a few colours Highlighted how lovely the others were	

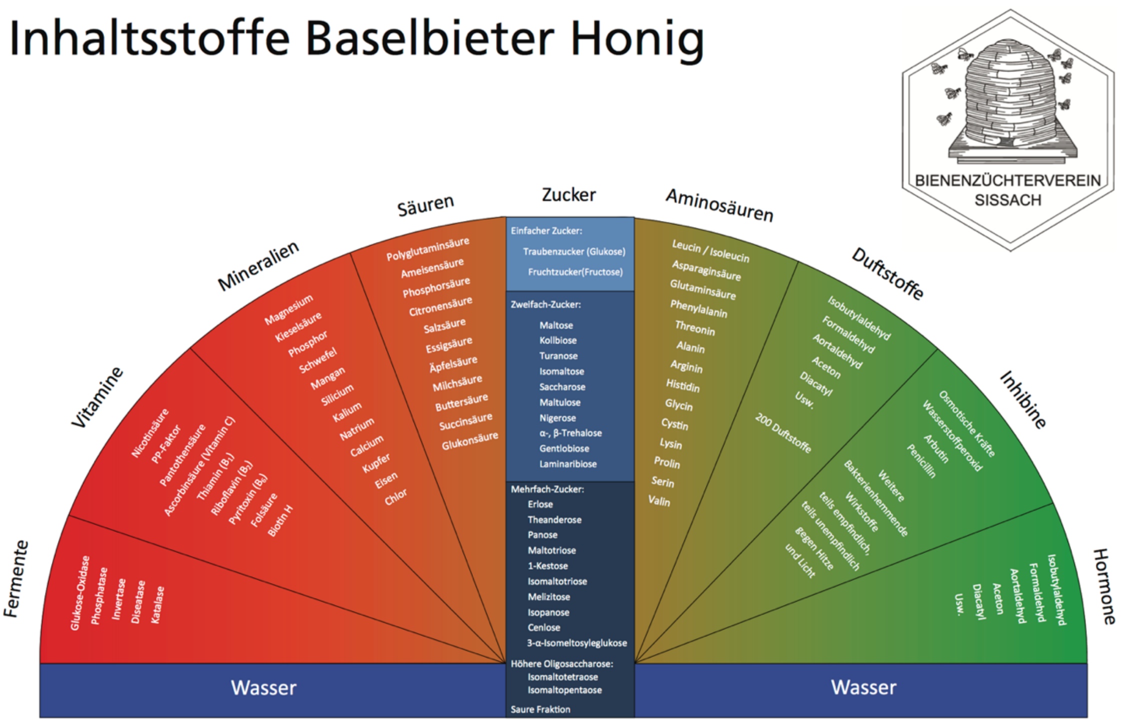
APPENDIX C

There is a danger in using the history of words as a means of understanding as Rudolf Steiner remarks:
"But the nature of a thing is not determined by how gradually the word designating it came about." (Steiner, An Outline of Esoteric Science, 1925) GA 13 ch.2 p. 48
First published in German, 1910

He has a different explanation of heathen culture:

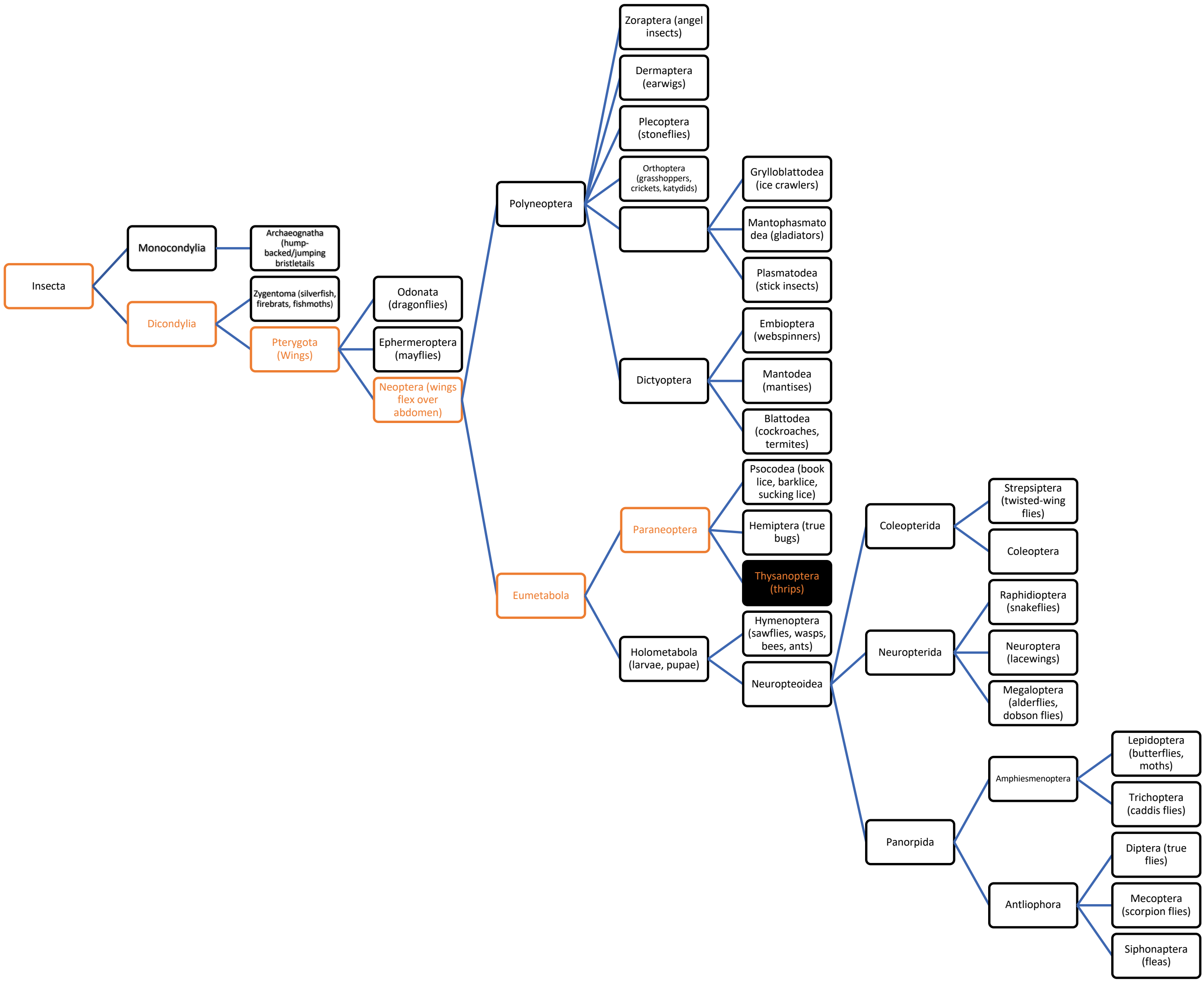
"Take earthly evolution prior to the Mystery of Golgotha. You find, spread over the earth, the heathen culture, and in a certain way separated from this, a culture which one could say was that of the Old Testament. What was particularly characteristic of this heathen culture? It contained a definite awareness of the fact that everything physical surrounding man contained a spiritual element. The heathen culture had a strong awareness of the nature of living thoughts which become transformed into dead thoughts. In the beings of the different kingdoms of nature, this culture saw everywhere the living element of which human thoughts were the dead counterpart. Heathen culture perceived the living thoughts of the cosmos and regarded man as belonging to these living thoughts of the cosmos.
…
The heathen world saw spirit in all of nature. There was no specific knowledge of nature in the sense of the natural science we have today, but there was an all-embracing knowledge of nature. Where people saw nature, they spoke of the spirit. This was a science of nature which was, at the same time, a science of the spirit. The heathen peoples were less interested in the inner being of man. They looked on man from the outside as a being of nature. They could do this because they saw all the other natural things as being filled with a soul element too. They did not think of trees, plants, or clouds as soulless objects. So they could look at human beings from outside in a similar way and yet not think of them as being soulless. Filling all nature with soul in this way, the ancient heathen was able to regard human beings as natural creatures.
…
The creed which then ran its course in the Old Testament was the polar opposite of this. The Old Testament knew nature neither in the way we know it — I mean in the way we come to know it as we turn towards spiritual science — nor in the way the ancient heathen knew it. The Old Testament knew only a moral world order, and Jahve is the ruler of this moral world order; only what Jahve wills takes place. So in the world of the Old Testament the view arose as a matter of course that one must not make images of the soul and spirit element. The heathen world could never have come to such a view, for it saw images of the spirit in every tree and every plant. In the world of the Old Testament no images were seen, for everywhere the invisible, imageless spirit ruled.
…
We ought to see in the New Testament a coming together of these two spiritual streams. People have always given prominence to either one view or the other. Thus, for instance, the heathen element was always predominant where religion was more a matter of seeing the objects of religion. Pictures were made of spiritual beings, pictures copied from nature. In contrast, the Old Testament element developed wherever the newer scientific attitude arose with its tendency towards a lack of images. In many ways modern materialistic science contains an echo of the Old Testament, of the imageless Old Testament. Materialistic science strives for a clear distinction between the material element in which no trace of spirit is left, and the spiritual element which is supposed to live in the moral sphere only, and of which no image may be made, or which we may not be allowed to see in the earthly realm.
This particular characteristic which is prevalent in today's materialistic form of science is, actually, an Old Testament impulse which has come over to our time. Science has not yet become Christian. The science of materialism is fundamentally an Old Testament science. One of the main tasks as civilization progresses will be to overcome both streams and resolve them in a higher synthesis. We must understand that both the heathen stream and the Jewish stream are one-sided and that, in the way they still exercise an influence today, they need to be overcome.
Science will have to raise itself up to the spirit. Art, which contains much that is heathen, has made various attempts to become Christian but most of these attempts have fallen into luciferic and heathen ways. Art will have to lead to a Christian element. What we have today is but an echo of the heathen and the Old Testament elements. Our consciousness is not yet fully Christian. This is what we must particularly feel when we consider factually, as described by spiritual science, the way in which human beings pass through birth and death."
(Steiner, Old and New Methods of Initiation, 1922) *GA 210 17th February 1922*

APPENDIX D



https://www.bienensissach.ch/wordpress/der-honigfaecher/

APPENDIX E
Insecta Taxonomy



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