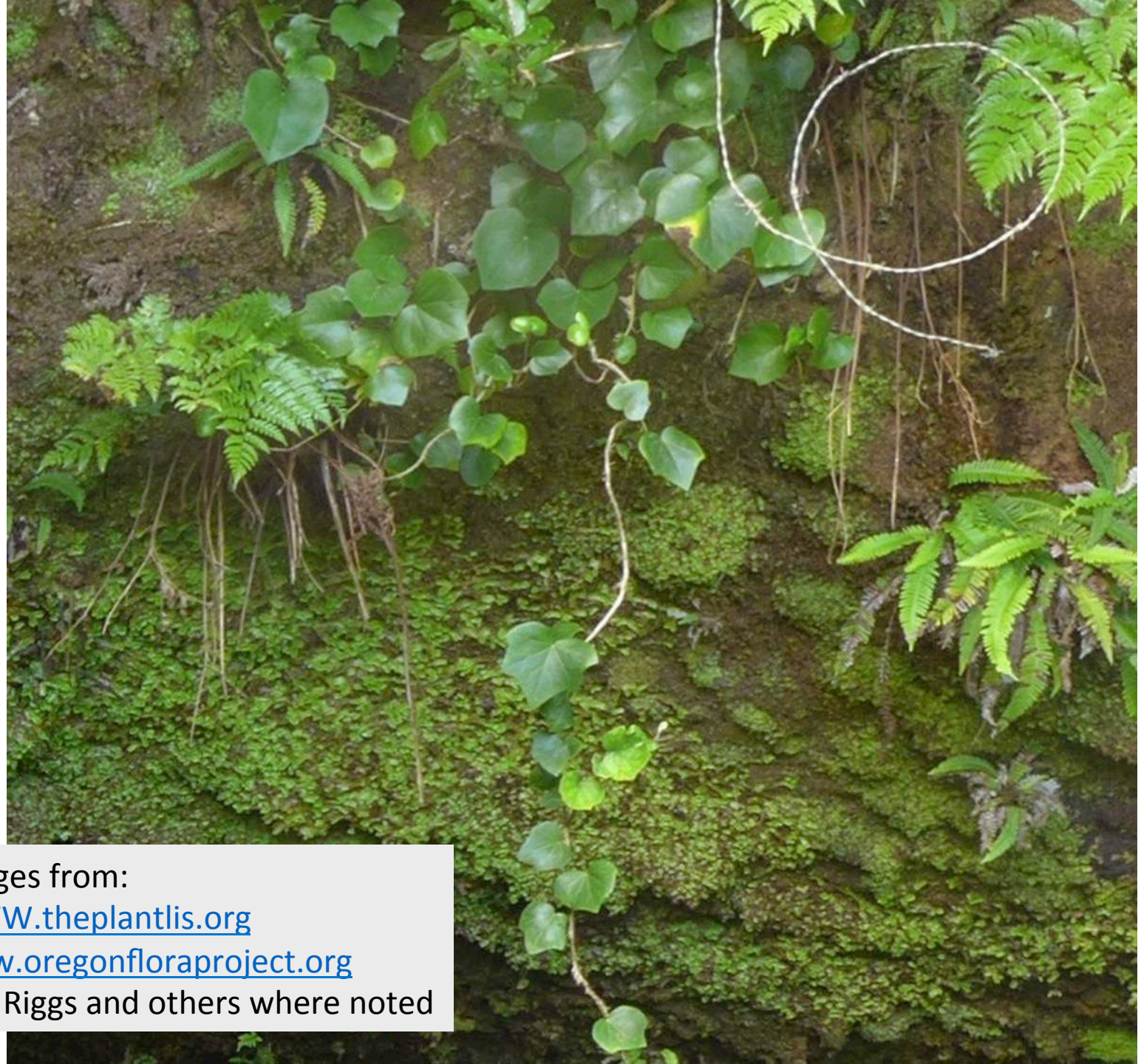


Images from:
WWW.theplantlis.org
www.oregonfloraproject.org
Erin Riggs and others where noted

“Hast thou seen in winter’s stormiest day
The trunk of a blighted oak
Not dead, but sinking in low decay
Beneath time’s relentless stroke:
Round which a luxuriant ivy had grown,
And wreathed it with verdure no longer its own?”

-Bernard Barton
(1784-1849)

Hedera (Araliaceae) Systematics, Taxonomy & Morphology

Erin Riggs
Systematist/taxonomist, Curator
HOYT ARBORETUM HERBARIUM, HAH
Erin.riggs@portlandoregon.gov

What is Systematics

Systematics is a foundation discipline fundamental to all biological science.

- **Phylogenetics- evolutionary history, reveals ancestor-descendant relationships. It investigates and shows how any organism relates to any other living organism evolutionarily.**
- **Biosystematics - studies of the evolutionary process, how, when, where - hybridization, genetic drift, mutations.**
- **Taxonomy- naming and ranking of species.**

Species identification is acutely important as it necessarily lies at the crux of discovery and revealing fine resolution of biodiversity.

Current urgency of systematics

HERBARIA DOCUMENT AND SUPPORT ACTIVE RESEARCH IN ALL THE FOLLOWING AND MORE

- Of particular importance to conservation work

- Tool to correctly describe and study organisms to further understand relationships with other living things and its critical for any biological study.

- We are in a race against EXTINCTION

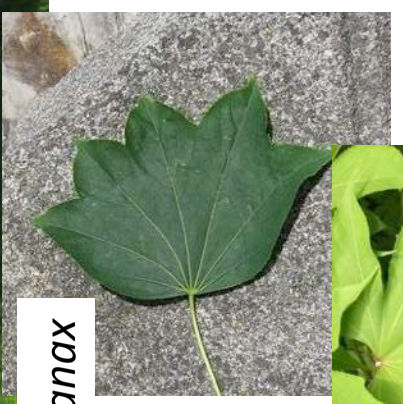
- Massive ecological change due to invasive species, climate change, human population, habitat degradation.

- Provides the only accounting of Earth's biota – plant list!! www.theplantlist.org
- Establish rules for proper classification and **nomenclature stability**
- Helps us organize diversity into workable groups (memory aid)
- **Phylogeography**

Hedera helix

Dendropanax
Fatsia
Trevesia
Hedera
Kalopanax
Eleutherococcus
Polyscias
Astrotricha
Osmoxylon
Tetrapanax
Tupidanthus
Gastonia
Reynoldsia
Tetraplasandra
Munroidendron
Arthrophyllum
Meryta
Pseudopanax
Panax
Aralia
Schefflera
Raukaua
Cheirodendron
Cussonia
Hydrocotyle
Trachymene

Araliaceae



Kalopanax

19 accepted named species of *Hedera*

Hedera algeriensis Hibberd
Hedera azorica Carrière
Hedera canariensis Willd.
Hedera caucasigena Pojark.
***Hedera colchica* (K.Koch) K.Koch, 1859**
Hedera cypria McAll.
***Hedera helix* L., 1753**
Hedera helix f. *poetarum* (Nicotra) McAll. & A.Rutherf.
***Hedera hibernica* (G.Kirchn.) Carrière, 1890**
Hedera iberica (McAll.) Ackerf. & J.Wen
Hedera maderensis K.Koch ex A.Rutherf.
Hedera maroccana McAll.
Hedera nepalensis K.Koch
Hedera pastuchovii Woronow
Hedera rhizomatifera (McAll.) Jury
Hedera rhombea (Miq.) Siebold ex Bean
Hedera rhombea var. *formosana* (Nakai) H.L.Li
Hedera sinensis (Tobler) Hand.-Mazz.
Hedera taurica (Hibberd) Carrière

Over 287 synonyms and or misapplied name within *Hedera*

Our *Hedera*:

Hedera helix – 86 synonyms - why?!

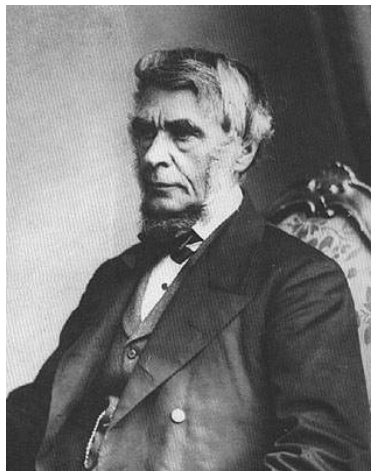
Hedera hibernica – 6

Hedera colchica – 25

18th and19th Century Systematists View of Plant Relationships

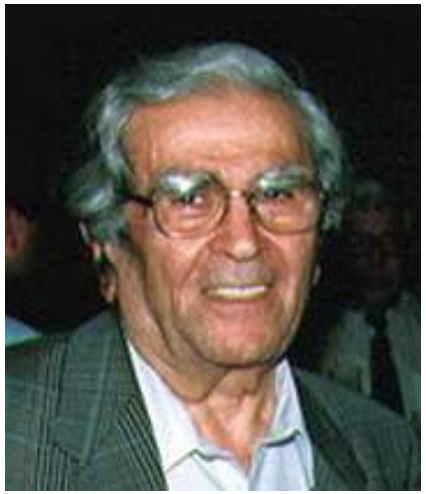
- These systematists had no evolutionary back ground.
- Plant relationships were reticulating or multidimensional.
- Continuous series, no distinct lineages (evolution).
- Some 20th century systematists, although evolutionarily trained still used 18th and 19th century techniques (Cronquist).
- Used “natural” groupings-this was defined many different ways by many systematists.
- Personality driven – Hooker, Bentham, Takhtajan, Cronquist

Sir William Jackson Hooker
1785-1865



George Bentham
1800-1884

Arthur John Cronquist
1919–1992



Armen Takhtajan
1910-2009

21st Century Systematists

- Unified evolutionary construct - Angiosperm Phylogeny Website www.mobot.org/MOBOT/research/APweb/ (Stevens, P. F. 2001)
- Genetics resolves many issues. Be aware a good investigation includes morphology as well.
- Global communication!! The Plant List, a working list of all plant species, www.theplantlist.org (Kew, MOBOT et. al. 2016).

Peter Hamilton Raven

Peter Stevens

Pamela Soltis

Mary Barkworth

Nomenclature stability MISAPPLIED NAME!!!

Perpetuation of misinformation

For literally decades the name *Hedera helix* has been misapplied to *Hedera hibernica* (Mitchell, K. 2010).

≠

Hedera helix

- Both professional and amateur botanists have made this error – not actually looking at the species in hand, and or not knowing there were several species in OR.
- Artifact of species list driven identification
- Until a couple of train taxonomists Dr. Peter Zika and great field taxonomist Ed Alverson brought this problem to our attention (Mitchell, K. 2010).

Our *Hedera:*

- *H. hibernica* far more common
- *H. helix* is out there but in much smaller populations
- Zika documented *H. colchica* in Curry Co. **Note**: Kendra Petersen-Morgan, Forest Park Ecologist, found a "suspicious looking" population of *Hedera* intruding into Forest Park in 2013. I determined it as *Hedera colchica*. So far it has only been officially document in SW OR. HAH now has vouchers/evidence of its spread.

Hedera hibernica

Hedera helix

If we are eradicating *Hedera* who cares what we call it?

Don’t be a sloppy scientist

- Wrong
- Our research has an impact beyond our local scientific community.
- Other researches trust the veracity of our work.
- Other ecologists depend on kill techniques working.
- Kill techniques may vary between and among species.
- Differences between and among species as shown by aspects of their ecology. (McAllister 1981; McAllister & Rutherford 1990; Ackerfield & Wen 2002, 2003; Grivet & Petit 2002).
- Need to data mine your research and make name corrections.

Kirsten GangGreen

Phylogeography

- The melding of biogeography and phylogenetics.
- Study of the **historical processes** that are responsible for contemporary geographic distributions of species.

Phylogenetic data reveal **genetic history and gene flow** within the geographic distribution of individuals and populations.

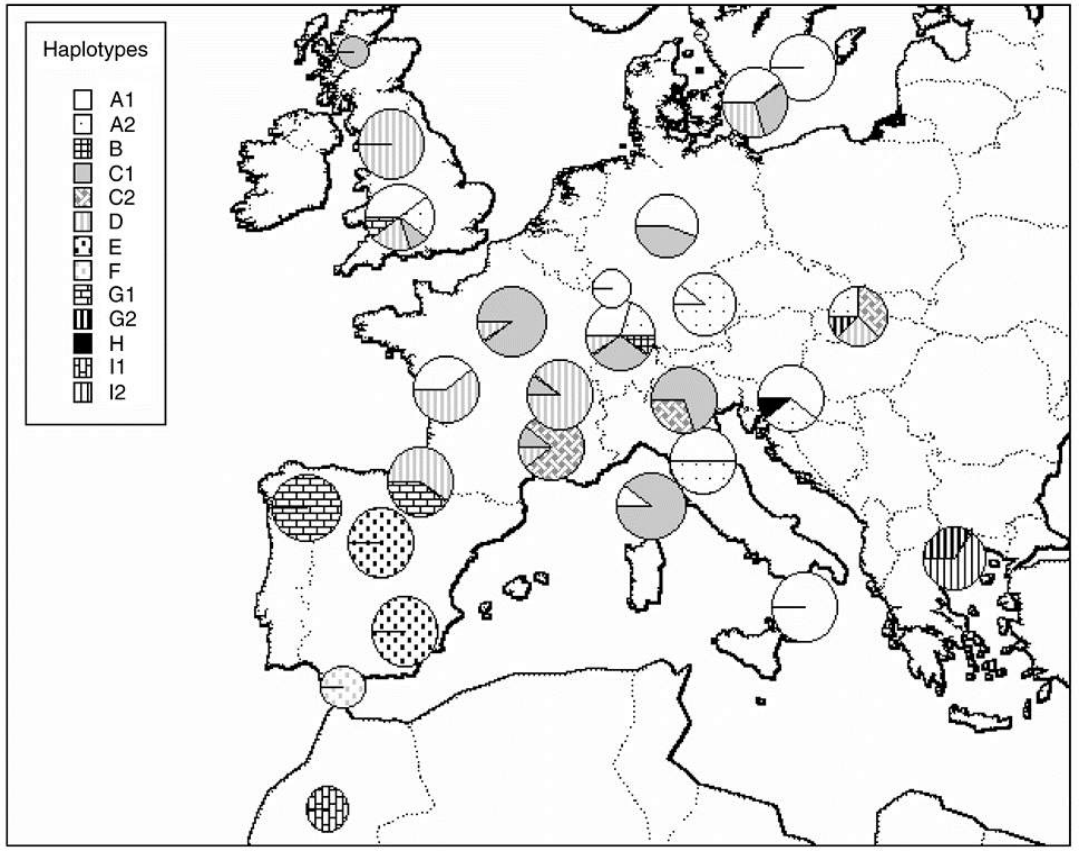
Recent investigation looking at phylogenetic identity of individual *Hedera* (including various cultivars) from 58 populations in PNW revealed: (Clarke 2006).

- 85% are *H. hibernica*
- 15% are *H. helix*
- This genetic data support *H. hibernica* as most responsible for invasion
- Both are sold as English ivy, correct naming in horticultural industry is a big challenge

Phylogeography

Study of the **historical processes** that are responsible for <u>contemporary</u> geographic distributions of species.

Evolution happens at the population level

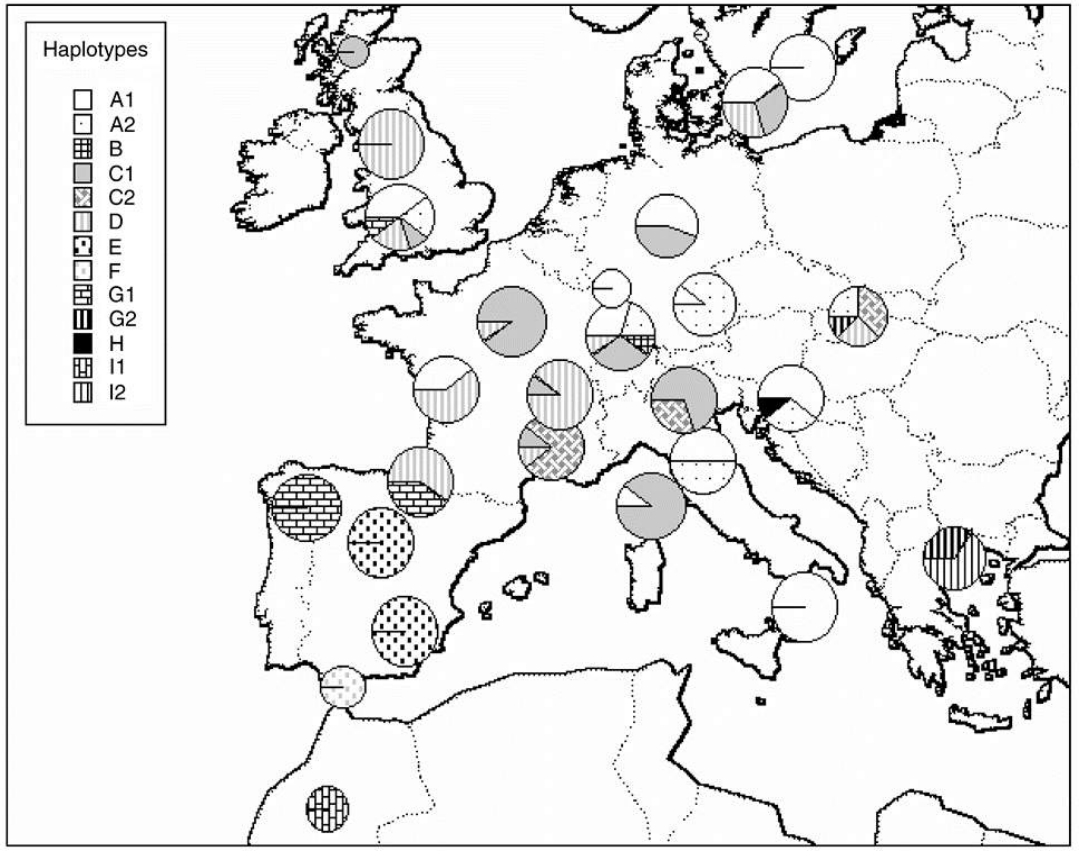


Geographic distribution of *Hedera* chloroplast haplotypes (Grivet, 2002). *Hedera* native to Europe.

Phylogeography

Study of the **historical processes** that are responsible for <u>contemporary</u> geographic distributions of species.

Range and distribution of *Hedera* in Oregon are incomplete!



Geographic distribution of *Hedera* chloroplast haplotypes (Grivet, 2002). *Hedera* native to Europe.

Phylogeography

Oregon Flora Project, OFP www.oregonflora.org. (Cook, Thea and Scott Sundberg, eds. 2012)

For literally decades the name *Hedera helix* has been misapplied to *Hedera hibernica* (Mitchell, K. 2010).

- Had over 200 mapped data points for *Hedera*
- Systematists/taxonomists conducted determination work on *Hedera* collection
- Reject all vouchers but 6!
- 1 is *H. helix*
- 3 are *H. hibernica*
- 2 unidentifiable by taxonomic determinators

OFP/OSU Herbarium is calling on all scientists and citizen scientists to make collections of *Hedera*

- Go OFP follow instructions for submission

Hoyt Arboretum Herbarium, HAH, is asking for submissions as well

- I will conduct determination
- HAH database is searchable at

www.hoytarboretum.gardenexplorer.org www.hoytarboretum.org. HAH upload data to Consortium of PNW Herbaria, in turn connects to iDigBio and OFP.

As of 2016 OFP has several *Hedera* locations mapped

Your collections are important for research (Culley 2013)
(Natural Sciences Collections Association www.natsca.org 2005) :

- Phylogeography
- Biogeography
- Exotic species management
- Climate studies
- Morphology

❖ Portland as a port city, is the epicenter of radiation of many exotic species.

WITHOUT COLLECTION LOCATION INFORMATION YOUR COLLECTION IS WITHOUT VALUE

LATITUDE AND LONGITUDE OR A MAP

"Unvouchered plant research is about as memorable as Whistler's father." Art Tucker's Law

For international transfer format data collection forms and Instructions on making collections – do not mount specimens.
email: erin.riggs@portlandoregon.gov

Sleep thou, and I will wind thee in my arms,
. . . . the female ivy so
Enrings the barky fingers of the elm
(‘Midsummer Night’s Dream’, iv., 1)


GET ON WITH IT!!!

MISAPPLIED NAME!!!

Perpetuation of misinformation

For literally decades the name *Hedera helix* has been misapplied to *Hedera hibernica*

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- Until a couple of train taxonomists Dr. Peter Zika and great field taxonomist Ed Alverson brought this problem to our attention.

Ours

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Taxonomy & Morphology
Diagnostic characters for precise Identification of our *Hedera*

Leaf Morphology

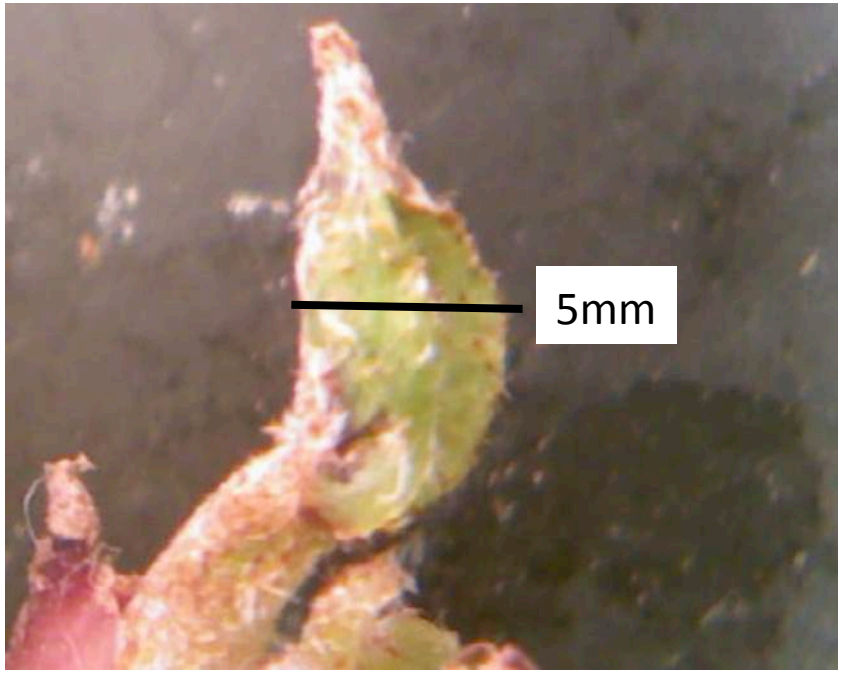
First true leaf, juvenile form

Cotyledons - primary embryo leaf

Leaf Morphology

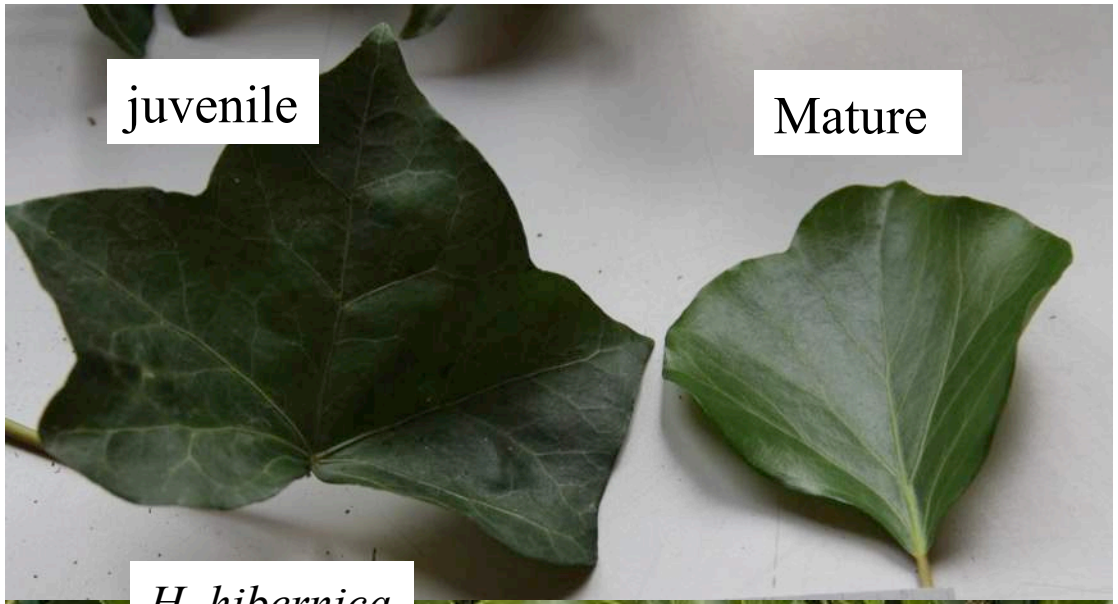
- Juvenile leaves
- Mature leaves with morphology

often associated with fruit .



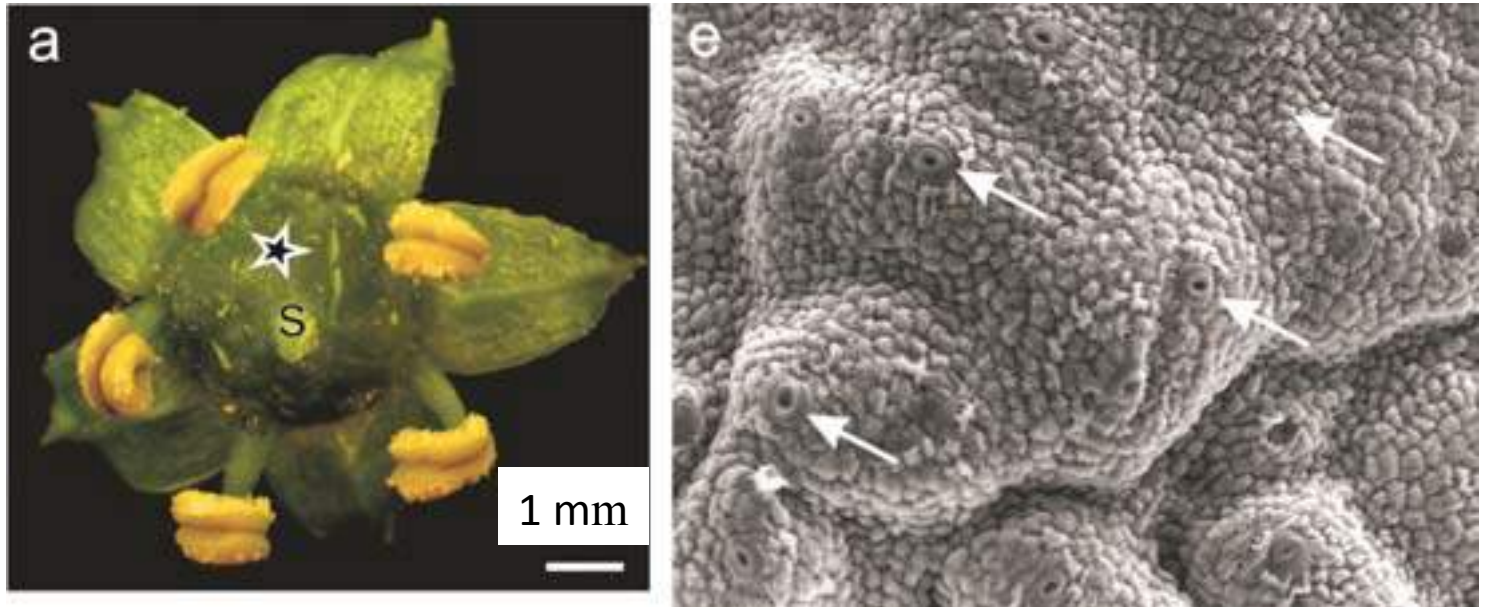
Very young juvenile shoot leaves

❖ Very important for precise identification

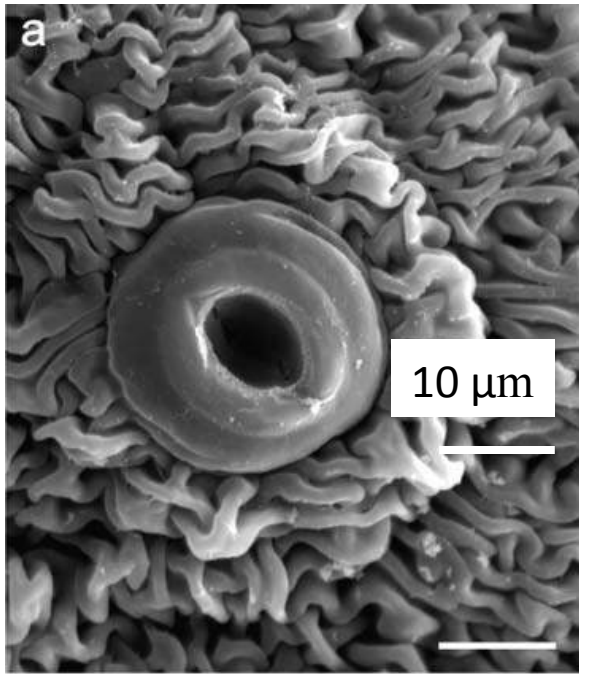


Inflorescence – racemose to globose umbels
Flowers – 5 merous
Calyx- of 5 sepals reduced to teeth around nectary rim
Corolla- of 5 petals
Nectary disc - provides food for nectar feeders (Vezza 2006)
Ovary – inferior

Hedera are visited for pollen or nectar (or both) by several insect species,
mainly Aculeate Hymenoptera (bees and wasps), Diptera (true flies) and Lepidoptera (moths and butterflies



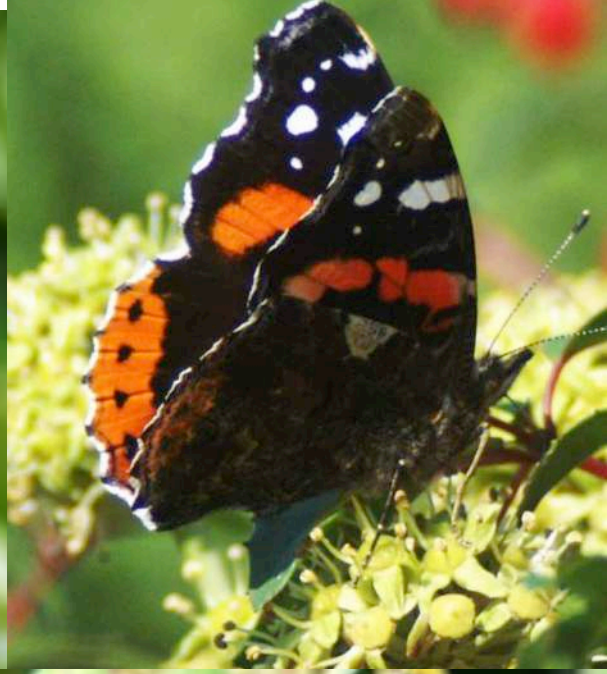
Nectary of *Hedera helix* in secretory stage. Flowers with a nectary on top of the inferior ovary. (e) fragment of a strongly undulated nectary surface with numerous stomata (arrows).



SEM image. Fully developed, stomata of the surface of *H. helix* nectary surrounded by massive cuticular striae.

Inflorescence – racemose to globose umbels
Fruit-berry, 2-5 seeds


© Roberto Colino



H. colchica

H. helix mature leaves

H. hibernica mature leaves

All 3 species we find here in Oregon are morphologically similar

- Adds to the identification confusion
- Juvenile leaves are very different from mature leaves – ID importance
- Mature leaves can be very cryptic
- Cultivars create further confusion
- **Trichomes** (hairs) very important for precise identification

Trichomes- diagnostic character

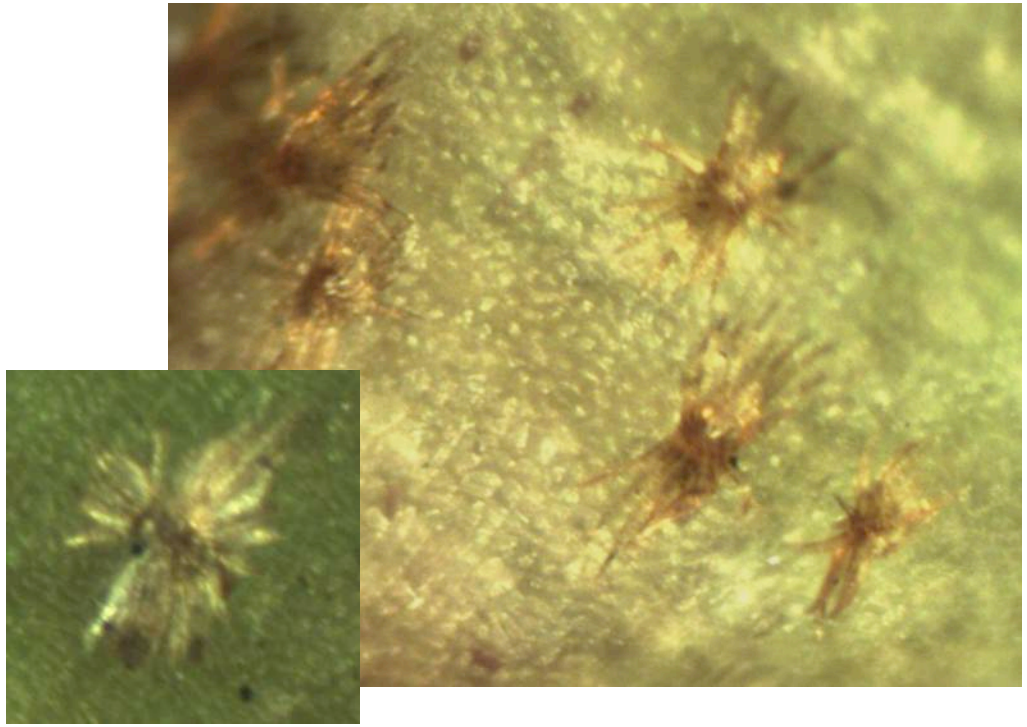
YOU CANNOT SEE THESE WITH THE NAKED EYE –
found on very young juvenile leaves

Hedera hibernica
Rotate stellate trichomes. Trichomes lay flat on leaf Surface, large 0.5-1mm, fewer than 10 rayed

Images Riggs 2013, 60x magnification

Hedera helix
Multiangulate stellate, white trichomes. Trichomes at right angle to leaf surface. large 0.5-1mm,fewer than 10 rayed.

Hedera colchica
Scale like trichomes. Trichomes lay flat, small 0.1-0.4mm, generally 10-20 rayed, center rays peltate. Start out white, become rusty brown.

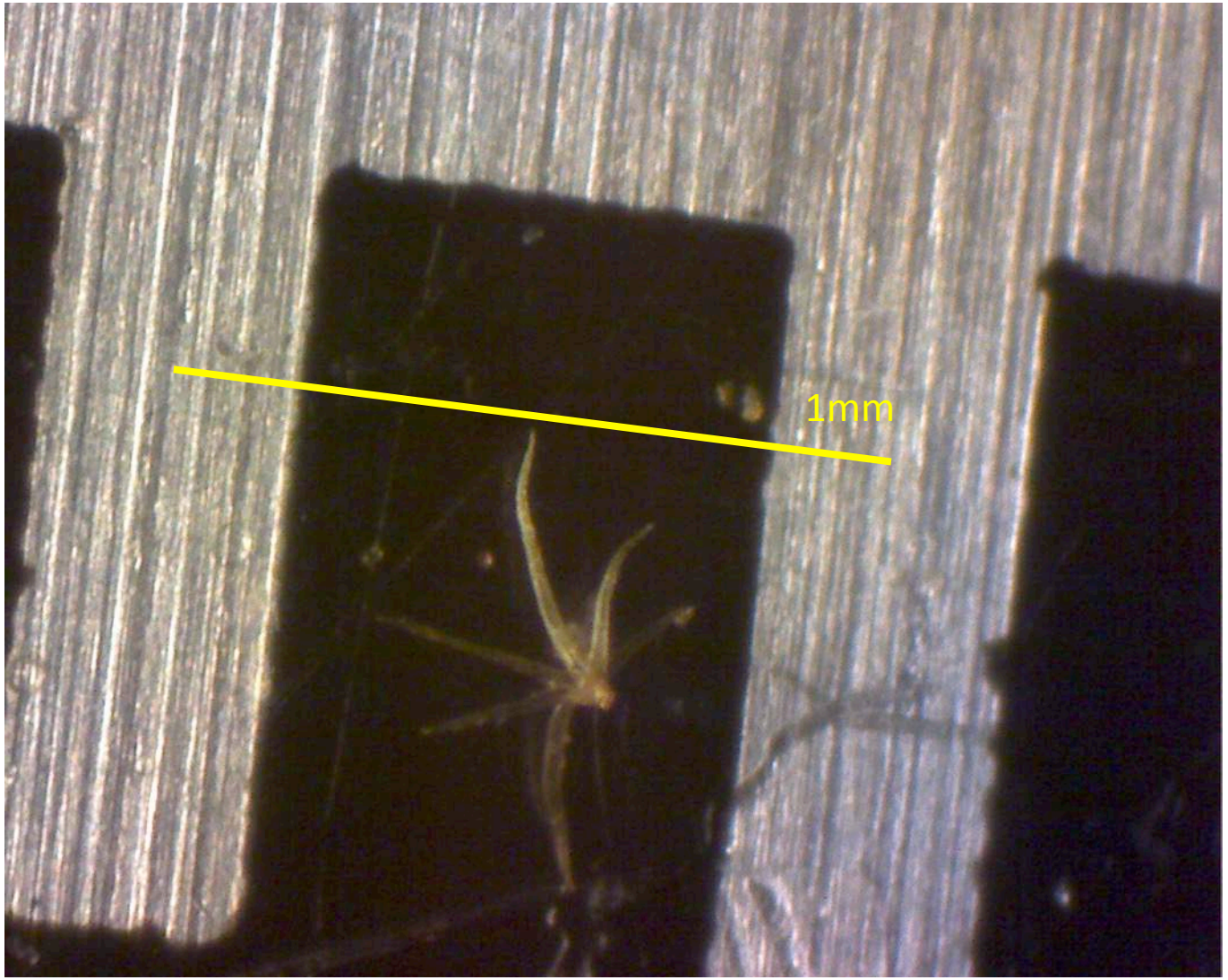


Images Riggs 2016, 60x magnification

Hedera hibernica trichome <1mm

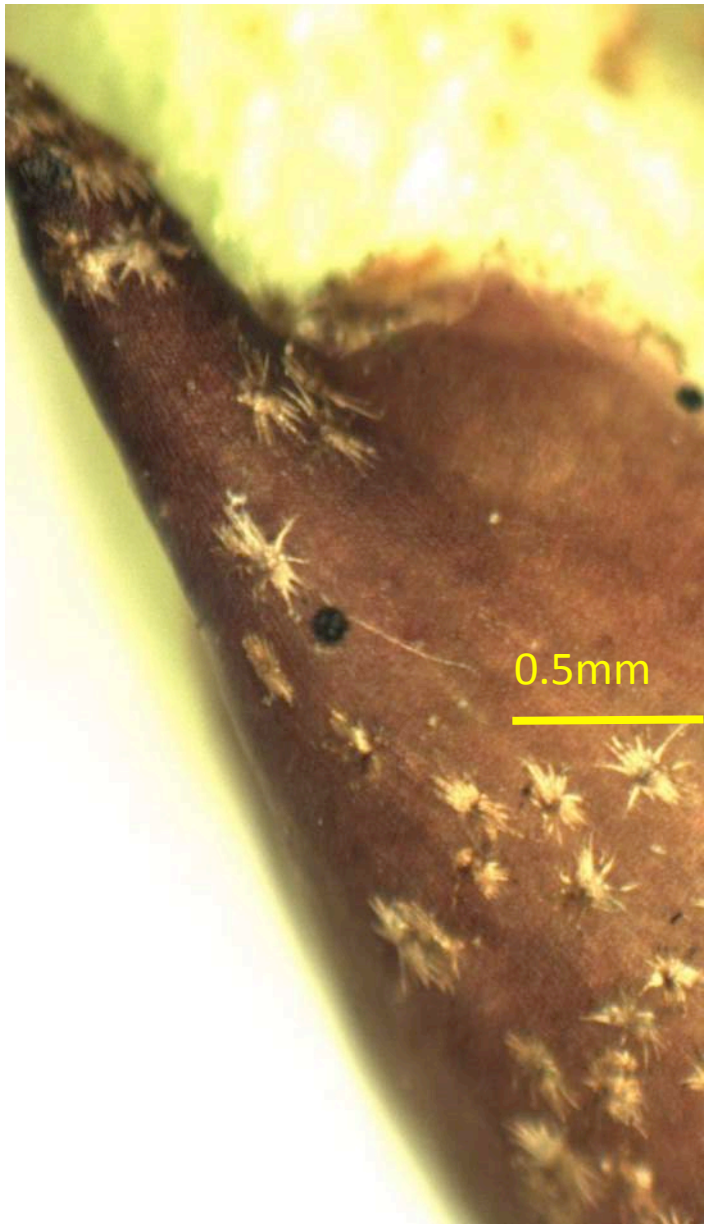
Images Riggs 2013, 60x magnification

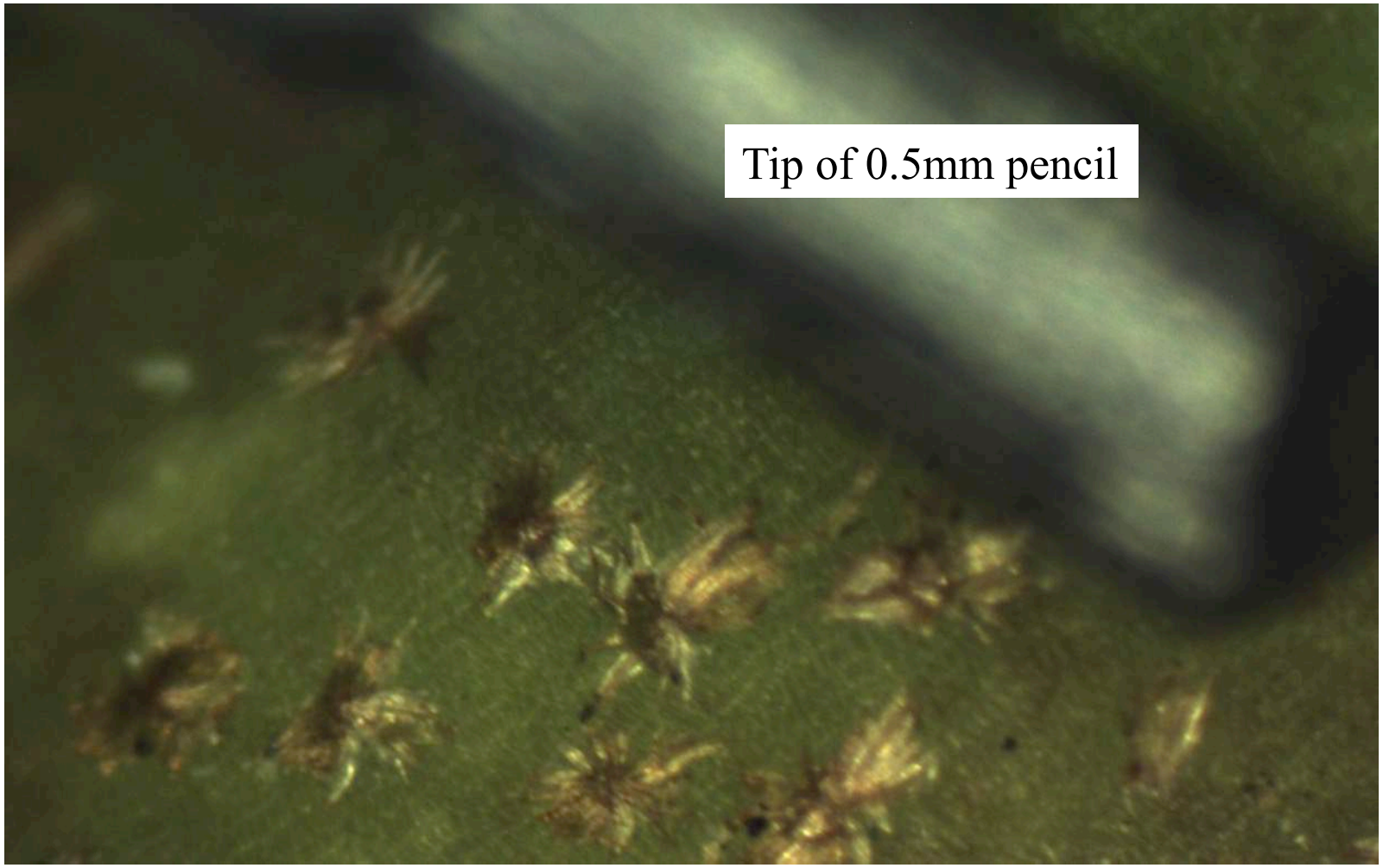
Hedera helix trichome <1mm



Images Riggs 2013, 60x magnification

Hedera colchica trichome <0.4mm





Best trichomes found on petiole and new buds.
Images Riggs 2016, 60x magnification

Trichomes

Caveat! And Tips for ID

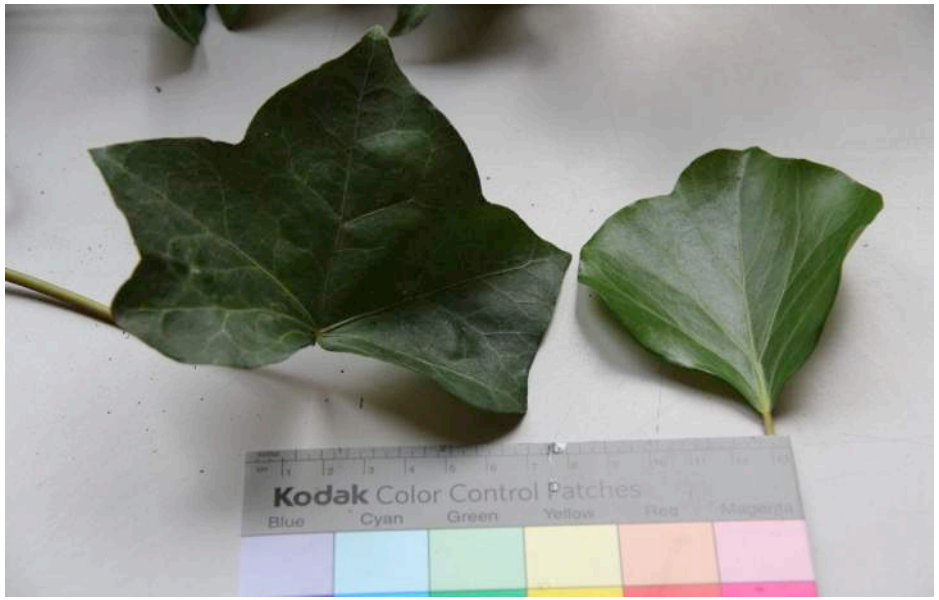
- Need dissecting scope 40x plus magnification
- Weather can rub off, or distort shape of trichomes, bending them flat
- Trichomes best observed on underside of leaf between main veins near petiole
- On a spot where leaves are protected
- On very young juvenile leaves that still have nice intact trichomes
- *H. colchica* on new buds and petioles

Hedera helix trichomes lose and piled up

Leaf characters may be helpful

Hedera hibernica
Leaf size - generally larger up to 10x10 cm

Leaf shape- pedate leaves more equal in surface, central lobe rounded



Hedera helix
Generally smaller
<10x10 cm

Pedate leaves more deeply lobed, central lobe acute

Images Riggs 2013

pedate-palmately divided leaf with lateral lobes 2 cleft

Leaf characters may be helpful

Hedera colchica

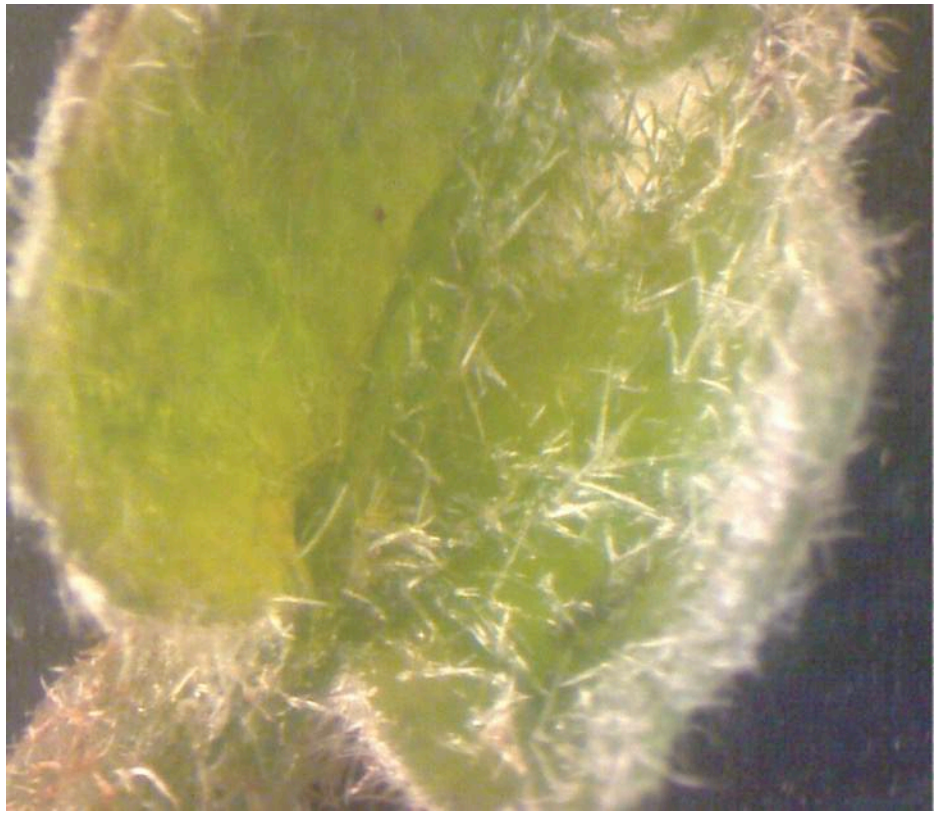
Mature leaves, unlobed or very shallowly lobed, large can be >10 mm long, leaves with very strong resinous scent when crushed

Images Riggs 2013

Juvenile Leaves diagnostic characters

Hedera hibernica

unlobed



Hedera helix

Always deeply lobed

About 5mm across each leaf

Images Riggs 2013

Juvenile Leaves

Hedera colchica

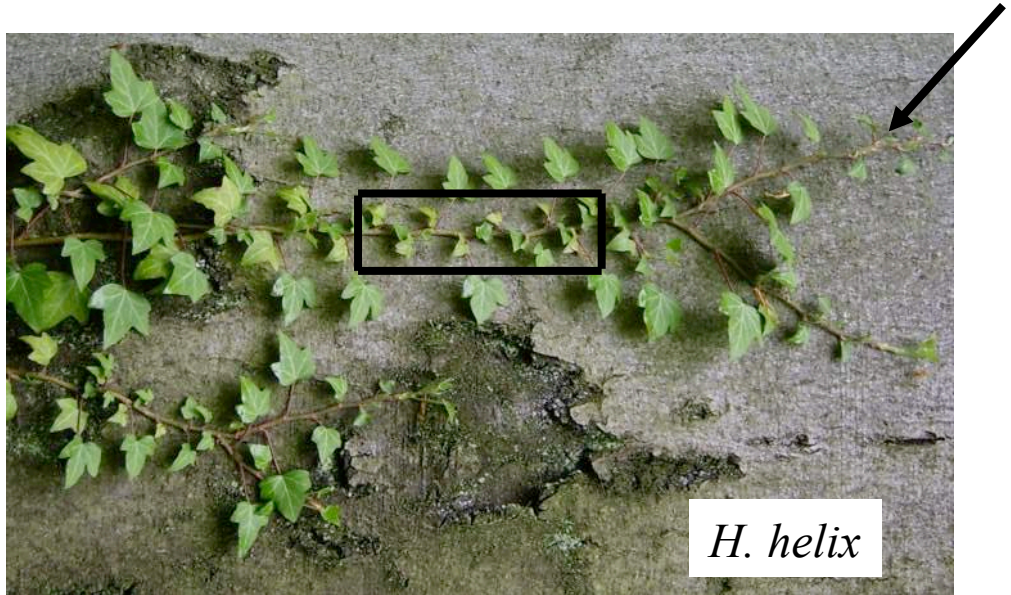
Folded leaf about 2.5mm across, unlobed

Images Riggs 2013

Leaves may be helpful for ID

Caveat! And Tips for ID

- Do not use older leaves.
- Do not use leaves found high on plant, morphological variability inconsistent.
- Young leaves have better consistent variability BETWEEN species.



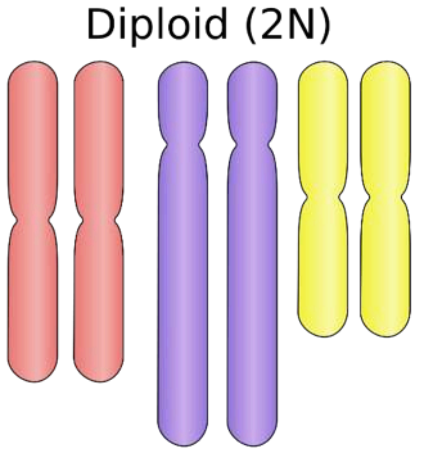
H. helix

H. helix

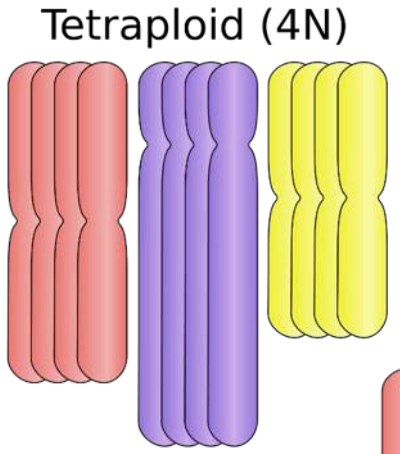
Hybridization?

They don't!
Different chromosome counts

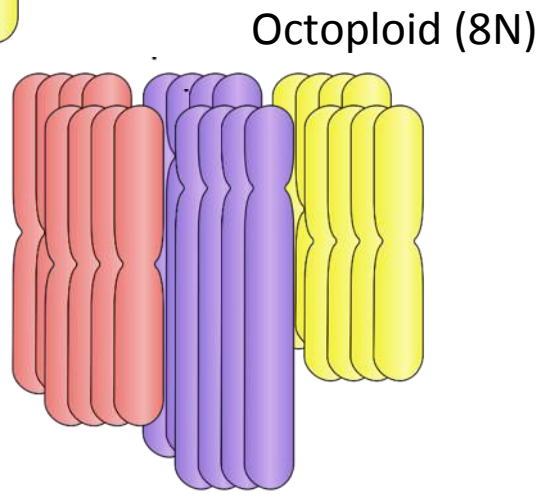
- *Hedera helix* - diploid 2n=48



- *Hedera hibernica* – tetraploid 4n=96



- *Hedera colchica* – octoploid 8n=196 interestingly is highest chromosome count in Araliaceae family (Vargas et al. 1999)



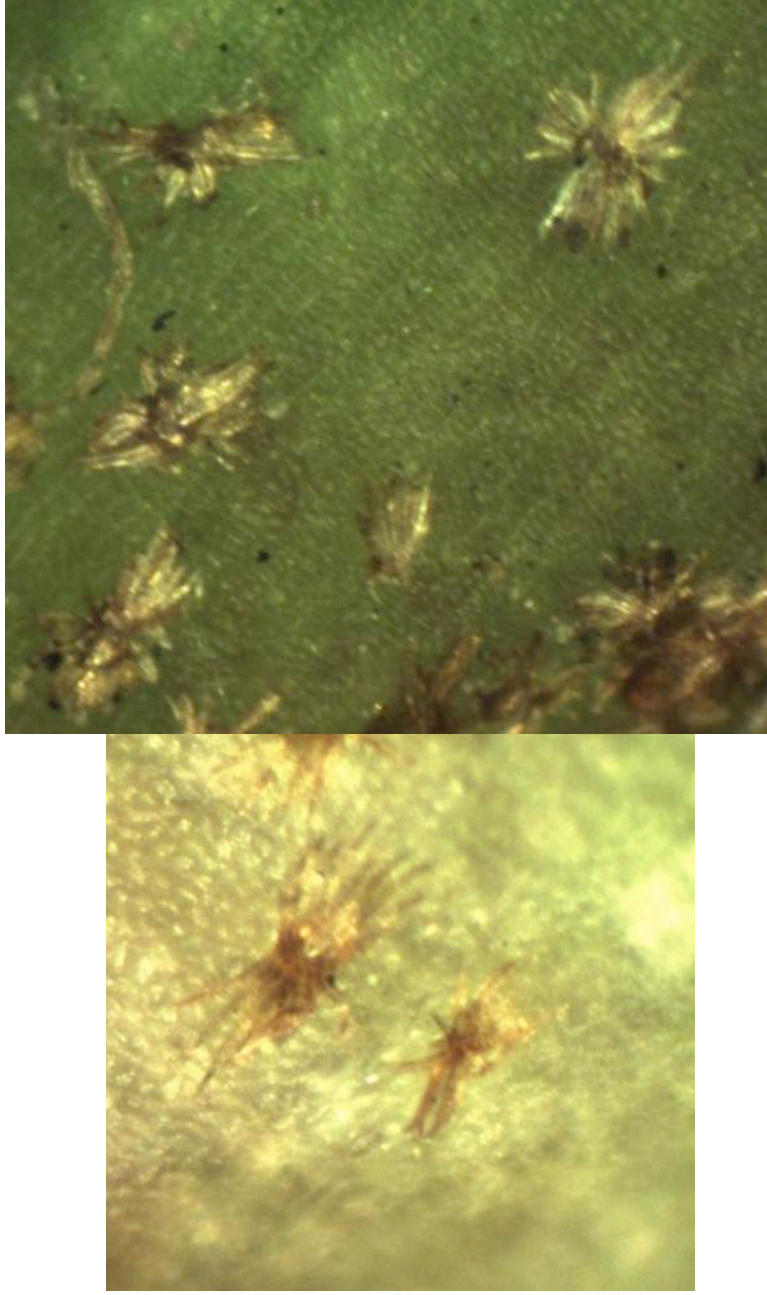

CULTIVARS CULTIVARS CULTIVARS!!!

Trichomes are the diagnostic characters

- Trichomes have not been selected for by plant breeders
- Trichomes not visible to the naked eye, 40x magnification or better, 30x if your experienced in *Hedera* ID.

H. hibernica

H. helix



H. colchica

Thank you

Beth Myers-Shenai
Integrated Weed Management Coordinator
Oregon Dept. of Agriculture, Noxious Weed Control

Martin Nicholson
Hoyt Arboretum Curator
Supporting Hoyt Arboretum Herbarium, HAH

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