C. Reisborg/SLU

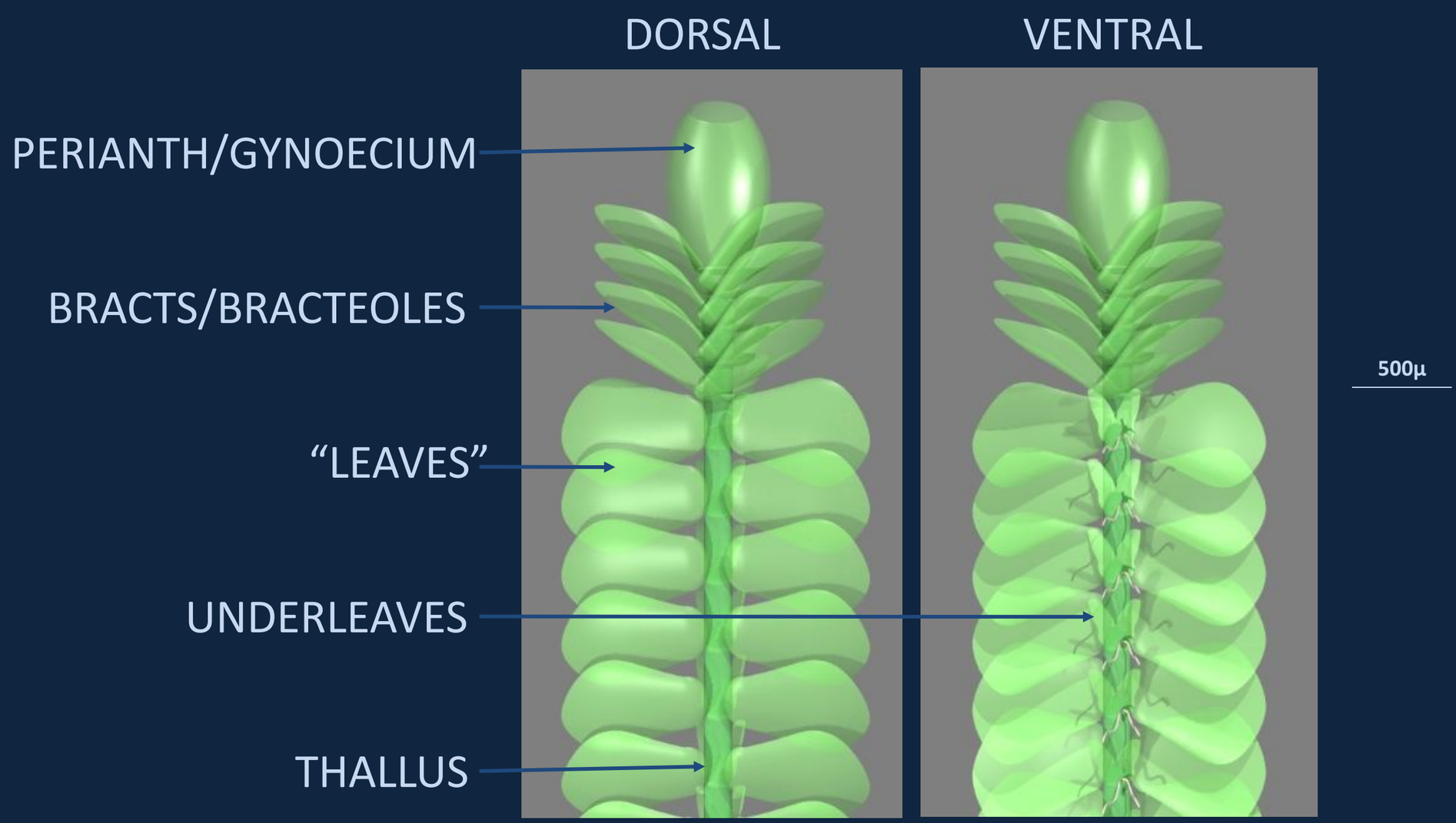
# Leaves and leafy bodies of liverworts in palynological samples from the Mesozoic of NW Europe

David Bailey
BioStrat Ltd

## FORCE Seminar

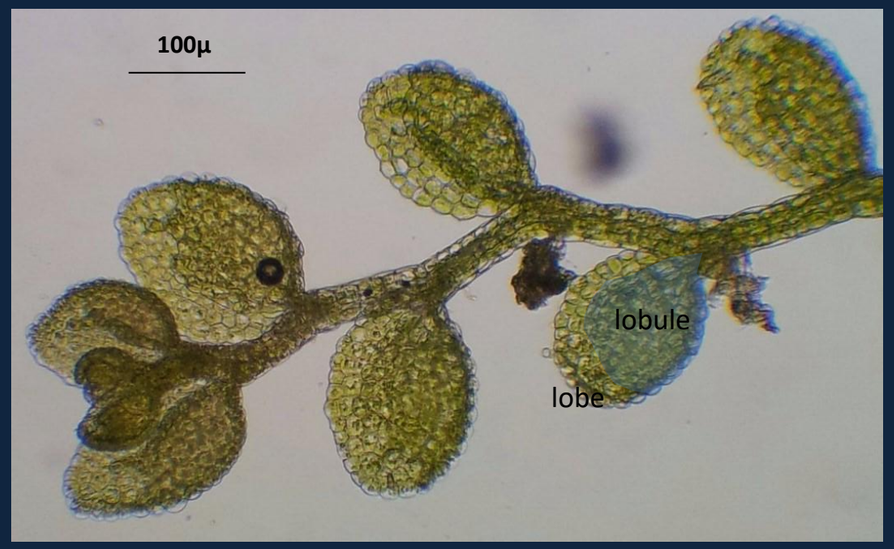
Stavanger
6th-7th March 2024

# Leafy liverworts

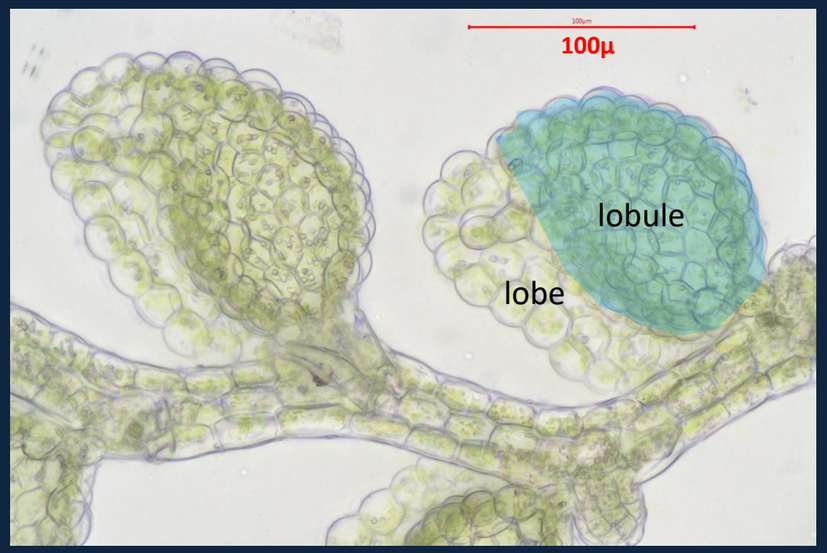



cronodon.com

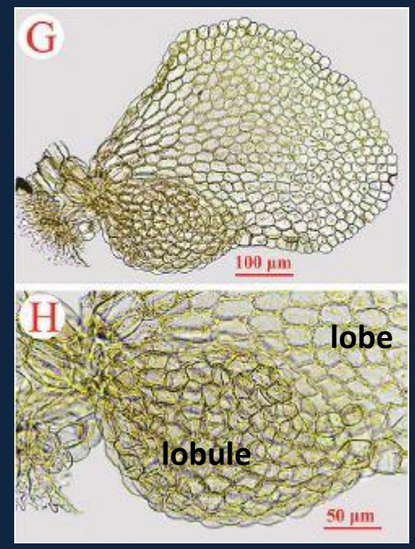
# Lobes, lobules & underleaves



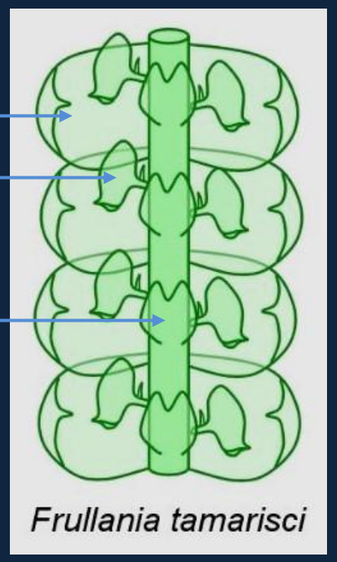

***Myriocoleopsis minutissima*** shoot
Uta Hamzaoui/naturespot.org




***Myriocoleopsis minutissima***. Clair Halpin-BBS

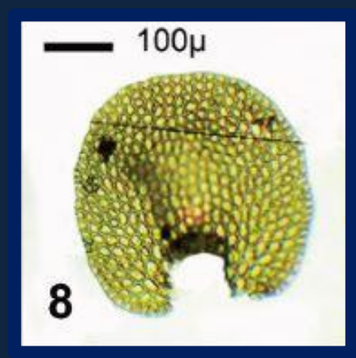



Gradstein et al 2017, Fig. 2

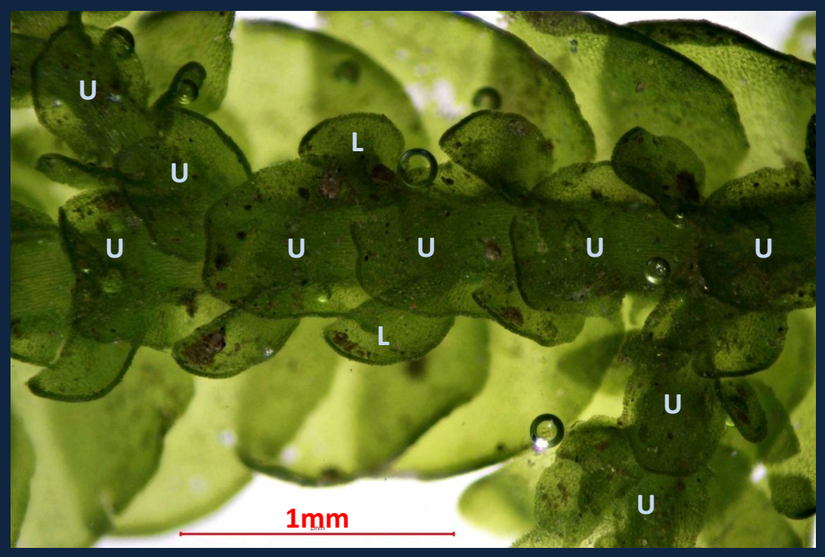



cronodon.com


***Jubula hutchinsiae***
Clair Halpin-BBS




***Acrolejeunea arcuata***
underleaf.
Pocs et al 2019 Fig 8

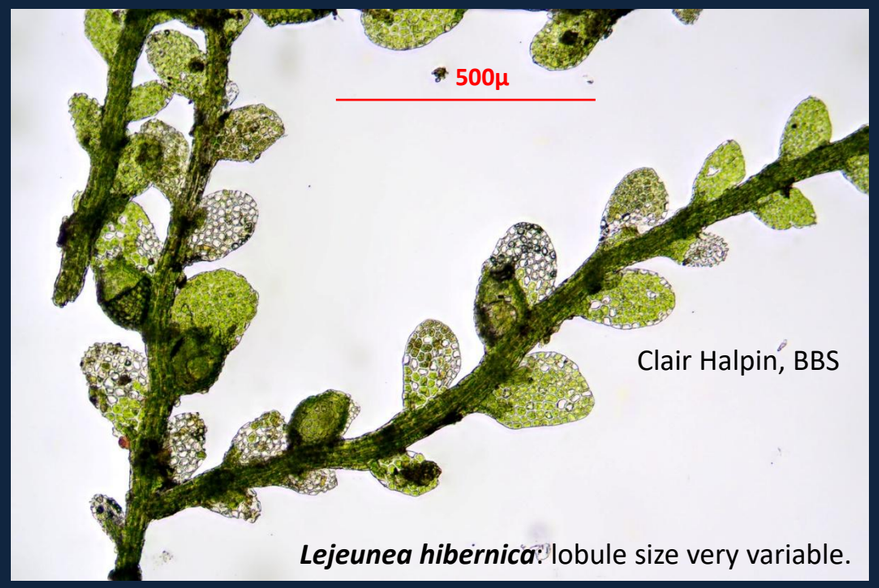



***Porella platyphylla***
**Clair Halpin-BBS**

# Leafy shoots


***Microlejeunea ulcina***: ventral view of shoot, focus on lobes. Clair Halpin, BBS


***Microlejeunea ulcina****:* ventral view of shoot, focus on lobules.
Clair Halpin, BBS




Clair Halpin, BBS

***Lejeunea hibernica***: lobule size very variable.


***Lejeunea cavifolia***: male shoot with perianth. Clair Halpin, BBS

# Leafy shoots

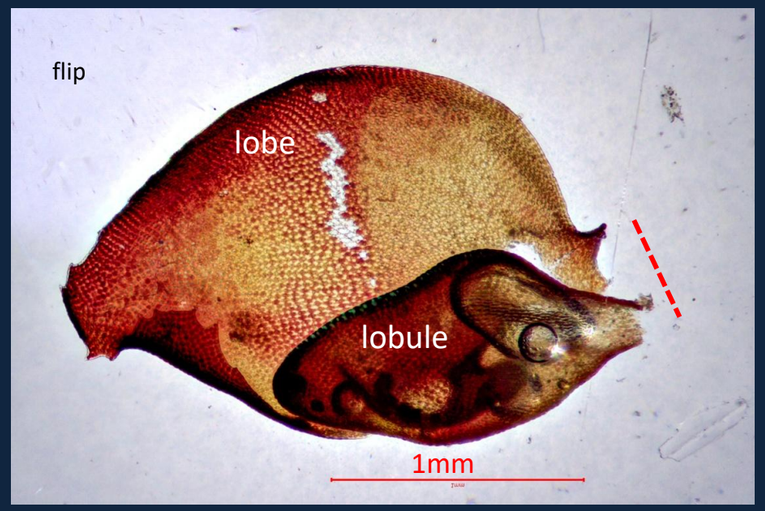

***Jamesonella autumnalis***.
C. Reisborg/SLU


***Micropterygium carinatum***.
https://plantasdepuertorico.blogspot.com
Ricardo Rico

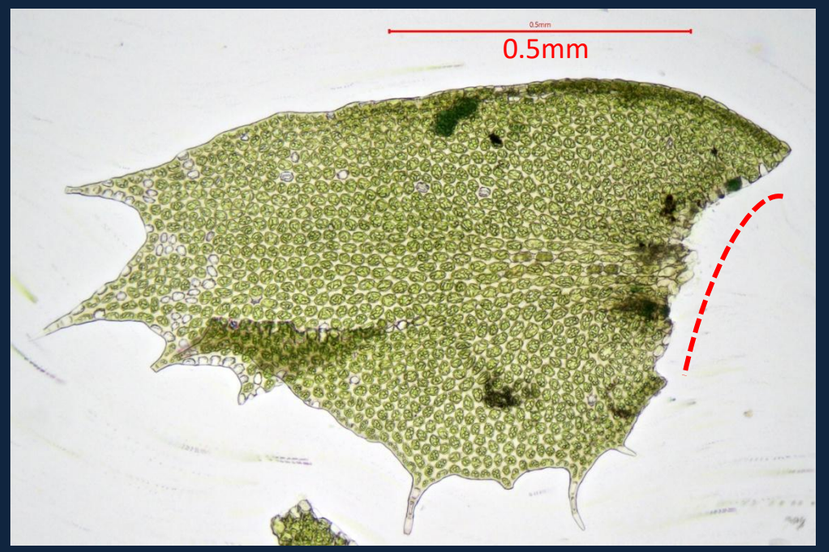

***Cephaloziella exiliflora***
Bluetier.org


***Lophozia ascendens***
C. Reisborg/SLU

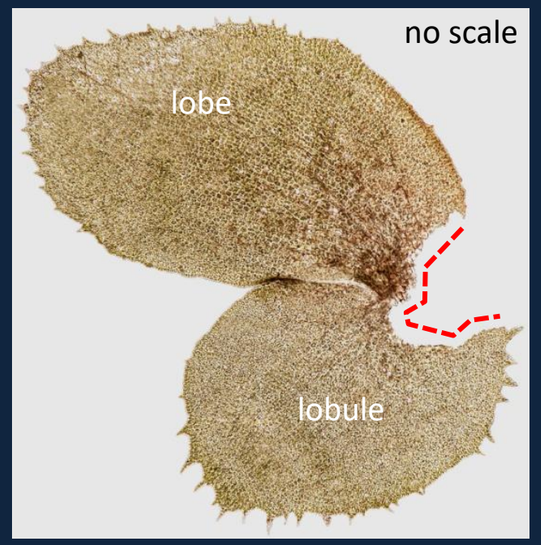
# Leaf: lobe, lobule and insertion



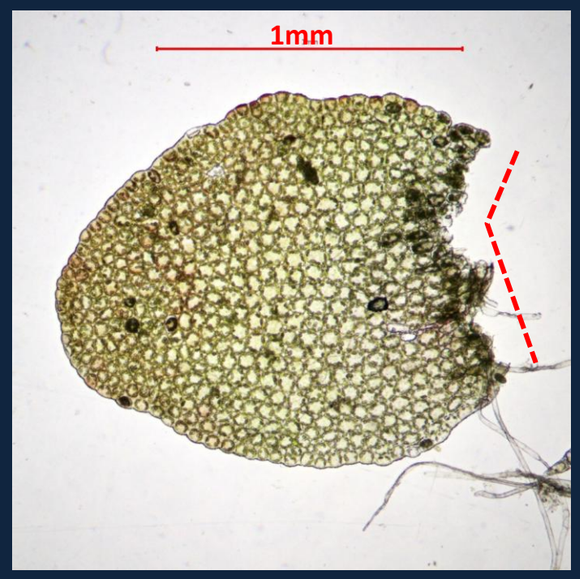

***Pleurozia purpurea*** Clair Halpin-BBS



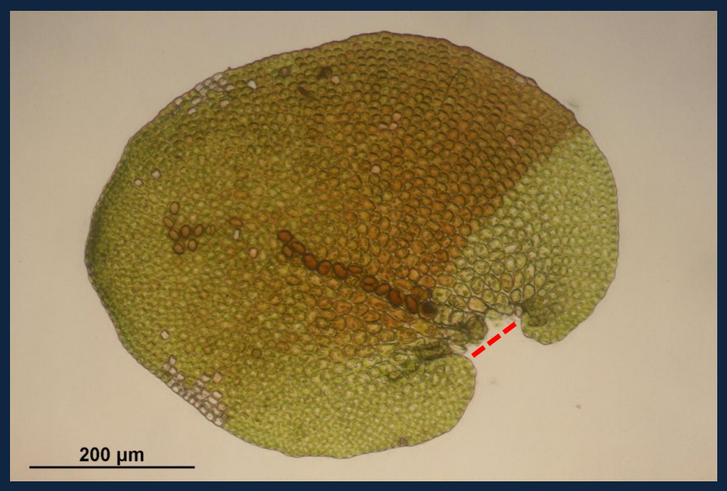

***Plagiochila bifaria*** . Clair Halpin-BBS



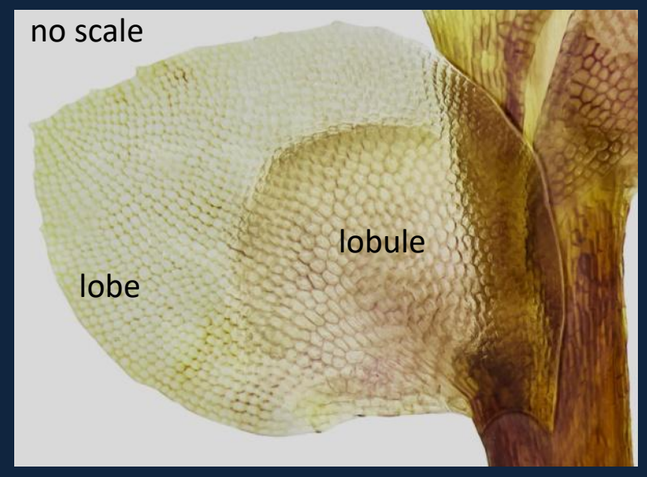

***Scapania gracilis*** C. Reisborg/SLU




***Mylia taylori*** Clair Halpin-BBS



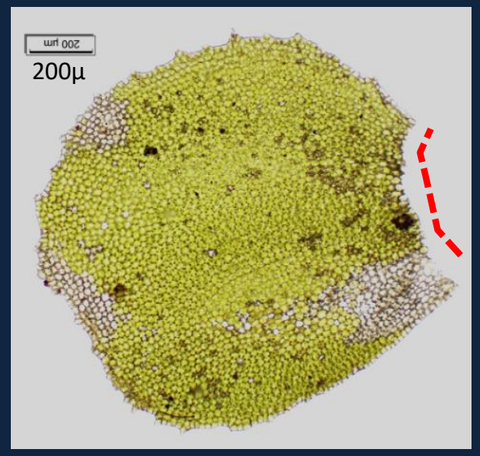

***Frullania tamarisci***
scotlandsnature.blog




***Scapania scandica*** C. Reisborg/SLU

leaf insertion

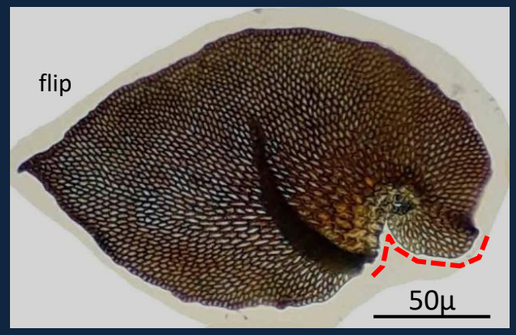
# Leaf: lobe, lobule and insertion



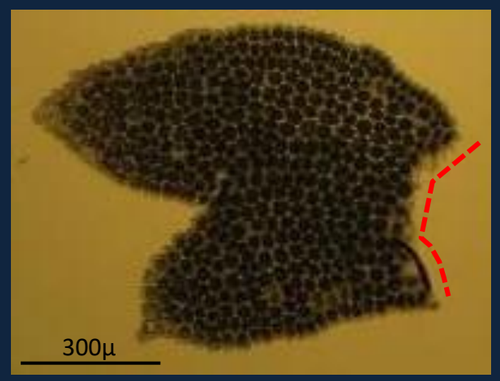

***Plagiochila asplenioides***
wnmu.edu/academic/nspages/gilaflora


***Plagiochila punctata***
Gradstein & Reeb 2022, Fig.13E

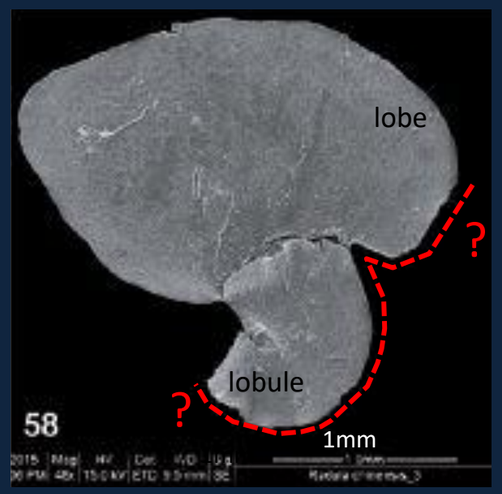

***Plagiochila punctata***
Gradstein & Reeb 2022, Fig.13E




***Frullania speciosa***
Coleção Flora do Brasil 2020
Jardim Botânico do Rio de Janeiro

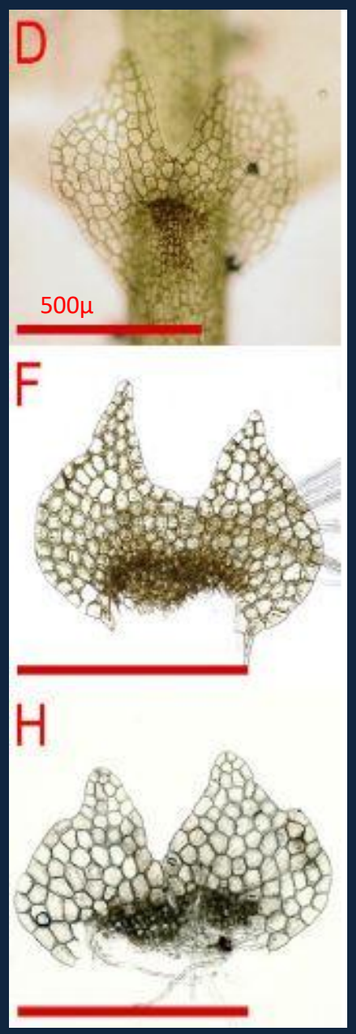



***Acrobolbus cinerascens***
Bluetier.org



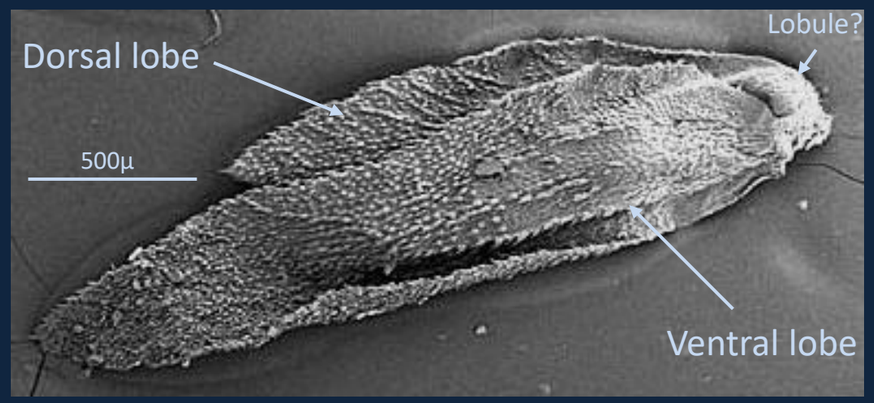

***Radula chinensis***
Singh et al 2016 Fig 58


***Orthocaulis atlanticus***
Clair Halpin-BBS



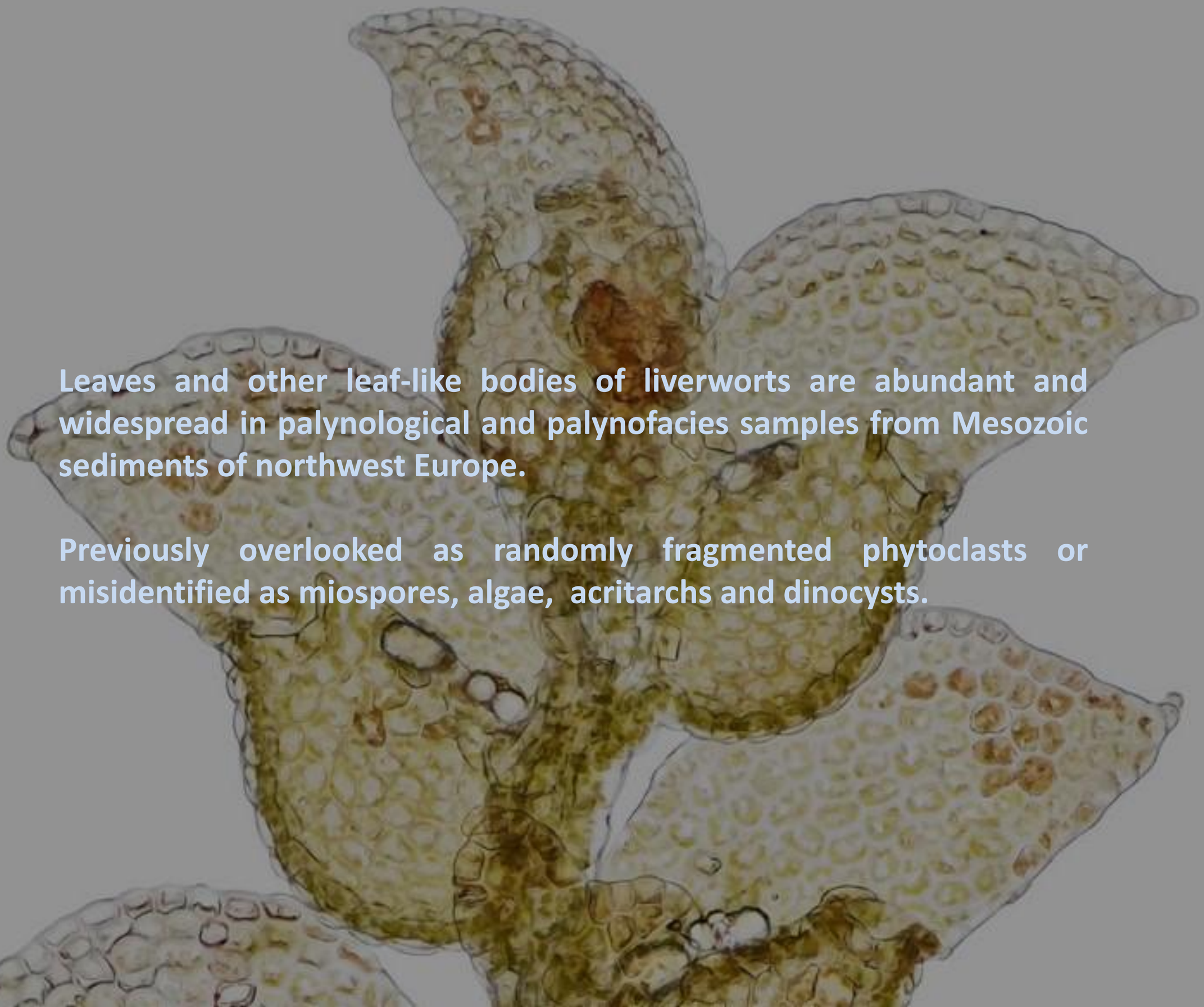

***Calypogeia kamchatica***
underleaves
Bakalin et al 2022 Fig 20 D F & H

leaf insertion




***Schistochila muricata*** bilobed leaf, asymmetric lobes

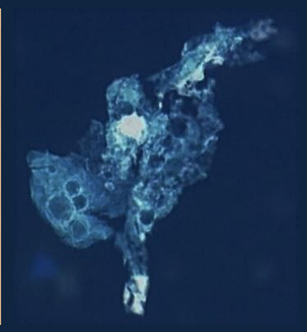

***Douinia ovata*** bilobed leaf
Korseby.net

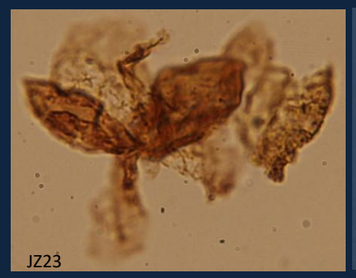


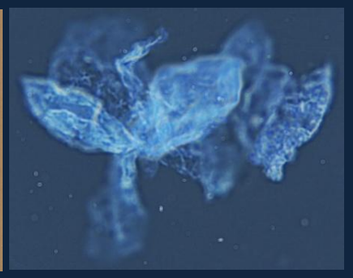
**Leaves and other leaf-like bodies of liverworts are abundant and widespread in palynological and palynofacies samples from Mesozoic sediments of northwest Europe.**

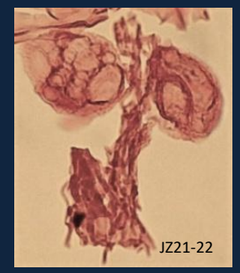
**Previously overlooked as randomly fragmented phytoclasts or misidentified as miospores, algae, acritarchs and dinocysts.**

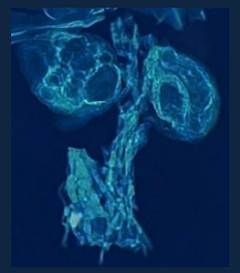
# Evidence in plant structures with attached leafy bodies

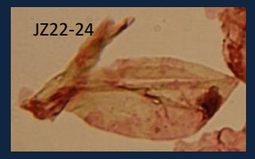


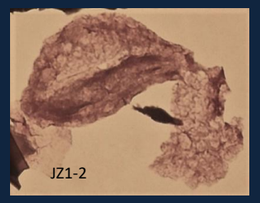



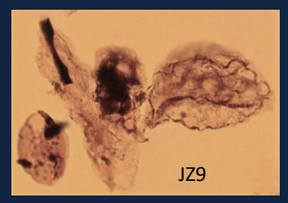


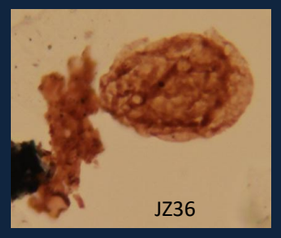



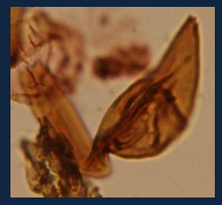
20µ

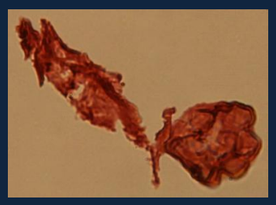


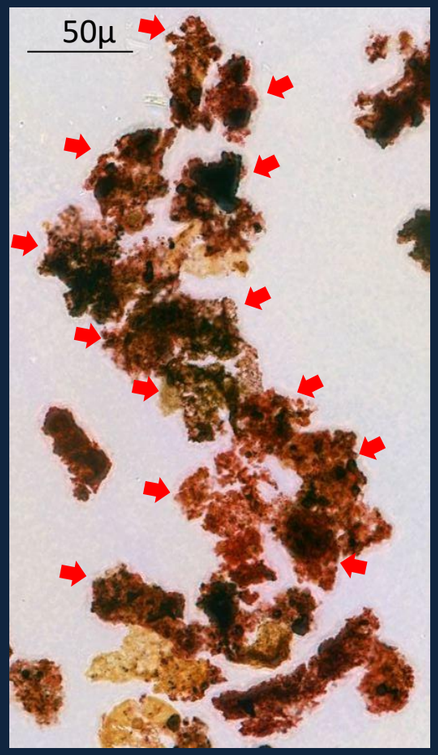






Fragments of leafy shoots

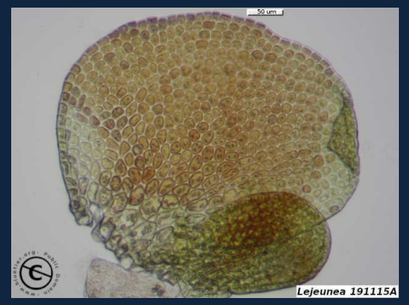

15/3-9 3981m Draupne Fm



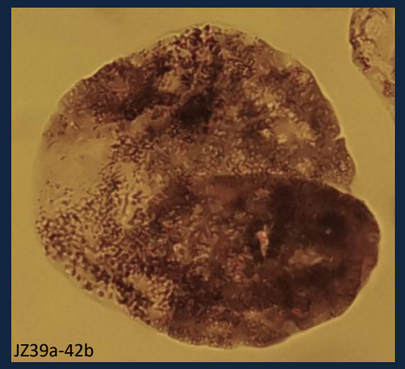

Kolmule Fm

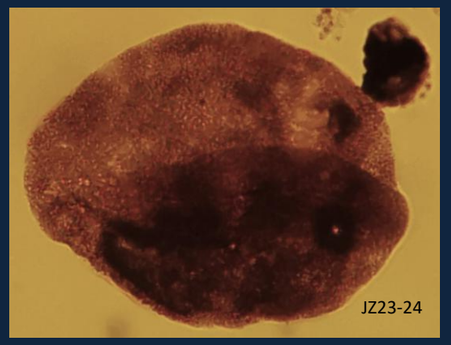
The focus of this presentation is on the isolated leaves

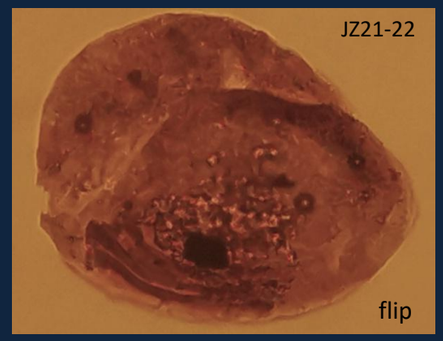
# Leaf; lobe and lobule

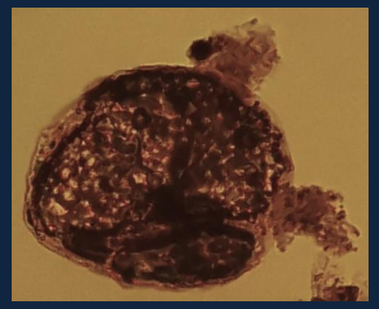



***Lejeunea* sp.**
Bluetier.org



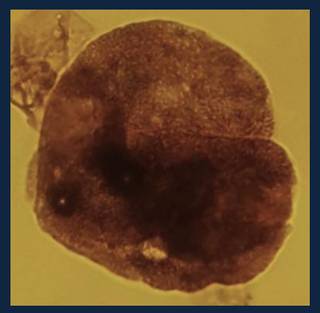



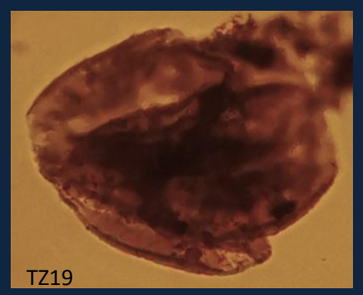



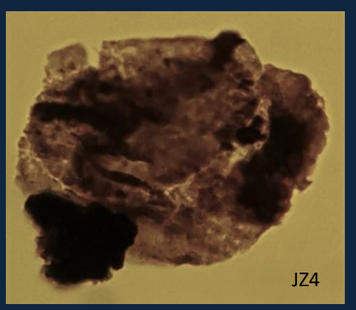



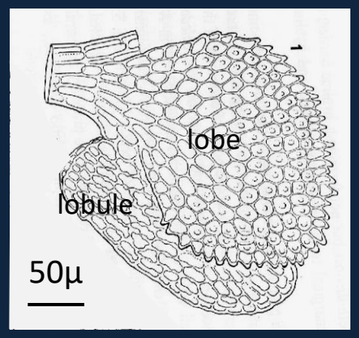
20µ

***Frullania bollanderi***
C. Reisborg/SLU



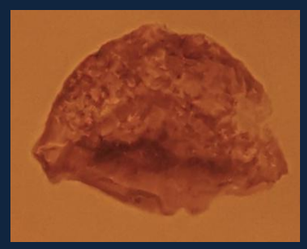


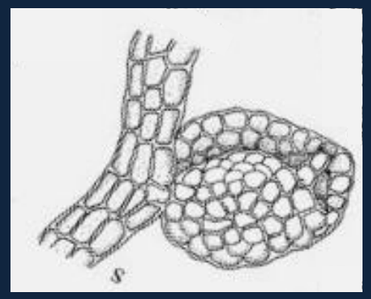



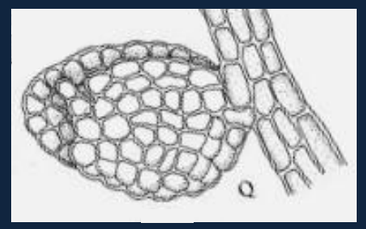

***Neohattoria caledonica***
bryophyteportal.org

7220/5-1 1337.00 Fuglen Fm

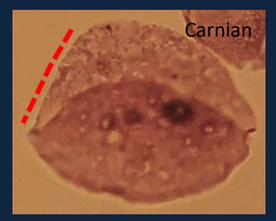


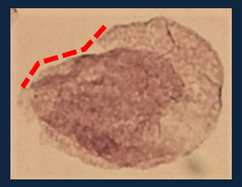
# Lobe, lobule and insertion

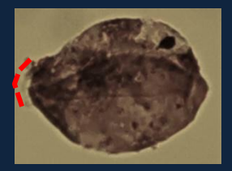


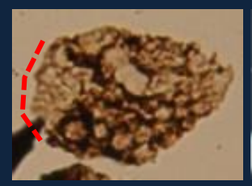


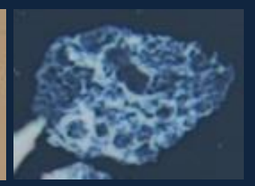
***Cololejeunea minutissima*** leaves
Singh & Kumar 2017, figs. 1Q & 1S



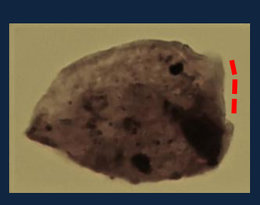



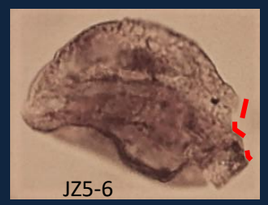


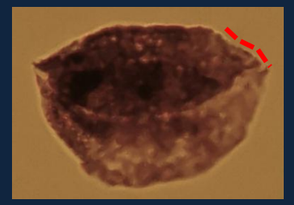




15/6-11A 4150m
Hugin Fm



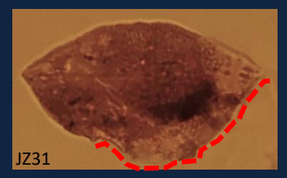


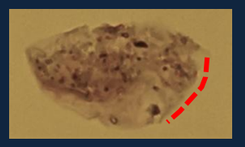



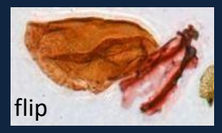

leaf insertion

20µ

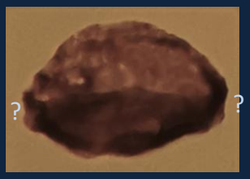


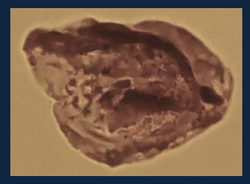


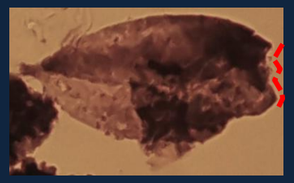




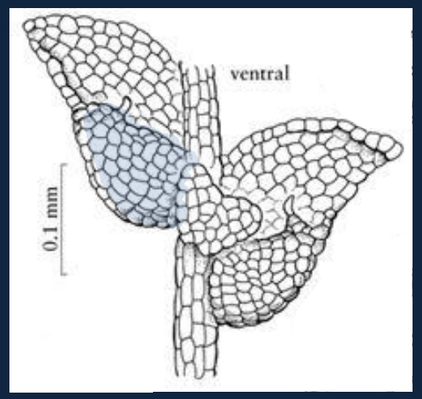





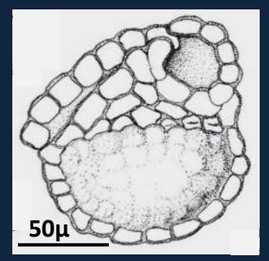




# Butterflies and blimps

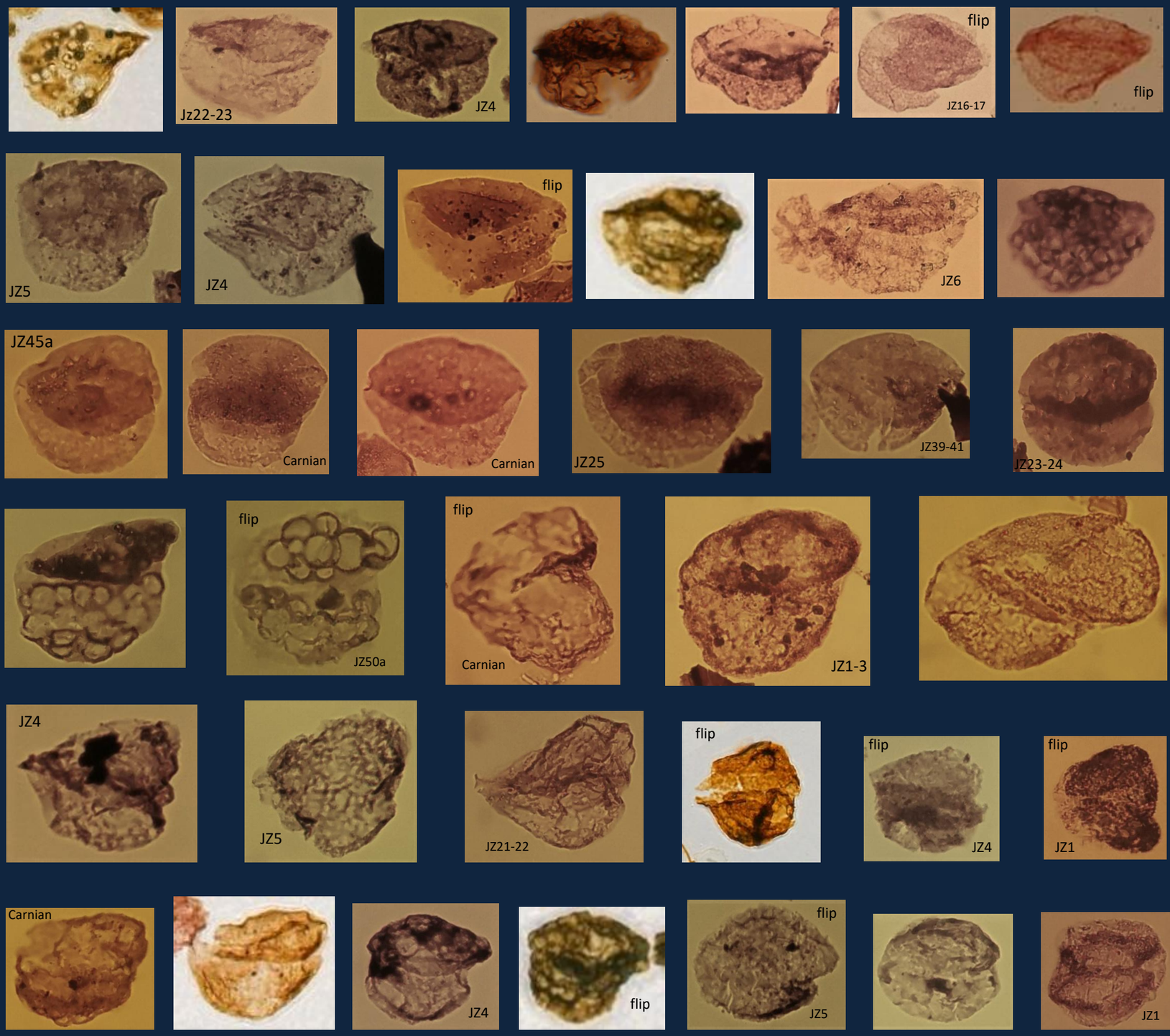



***Harpalejeunea*** leaves
mobot.org



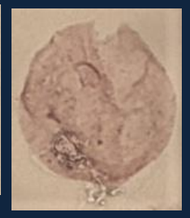

***Microlejeunea strasbergii***
Ah-Peng & Bardat 2016, Fig. 1B

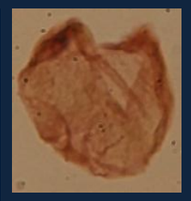

***Scapania crassiretis***
C. Reisborg-SLU Art databank

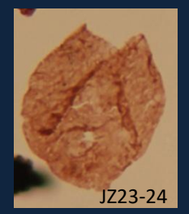


# Underleaves

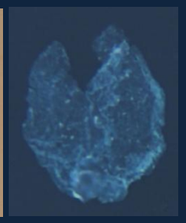
***Ceratolejeunea***
underleaf Dauphin 2000

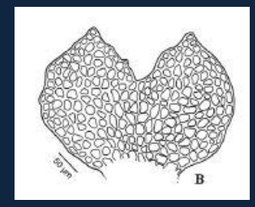







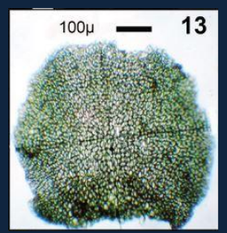




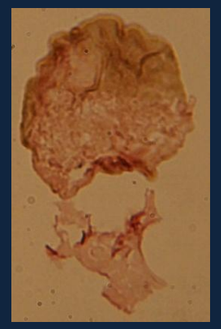



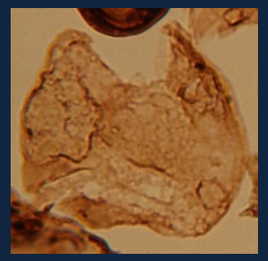
***Pycnolejeunea papillosa***
Tavares-Martins *et al* 2017 Fig 4B

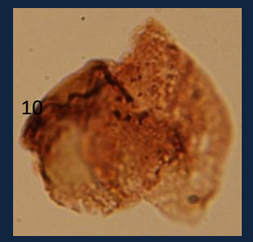
20µ




***Bazzania srulatioides***
Pocs et al 2019 Fig 13

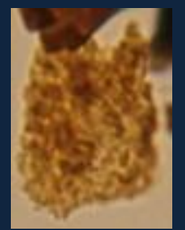


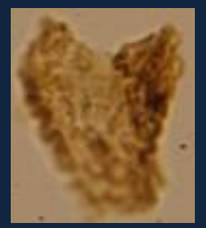


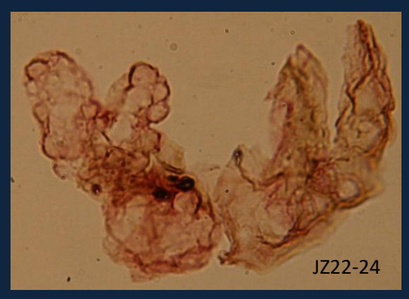

***Frullania calcarifera***
Borovichev & Vilnet
2015 Fig 1 .13

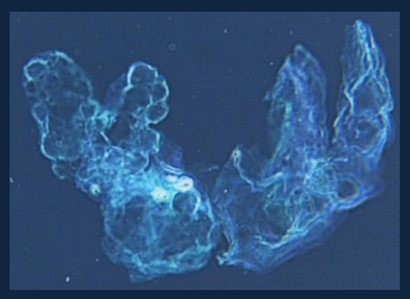
15/5-7 3672m
Draupne Fm KZ1-



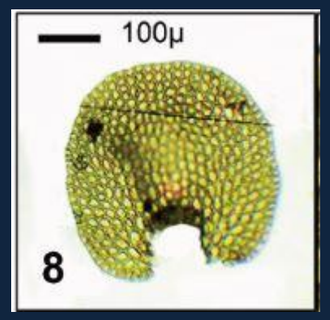


***Lepidozia reptans***
C. Reisborg/SLU

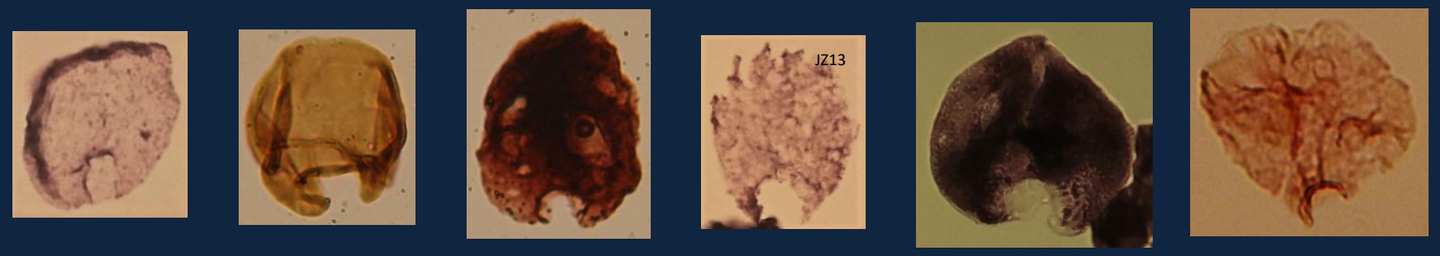


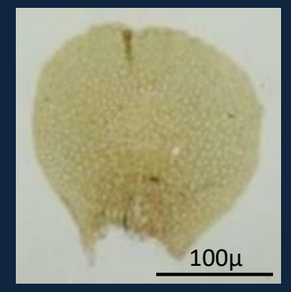
# Leaves or underleaves?




***Acrolejeunea arcuata***
.underleaf
Pocs et al 2019 Fig 8

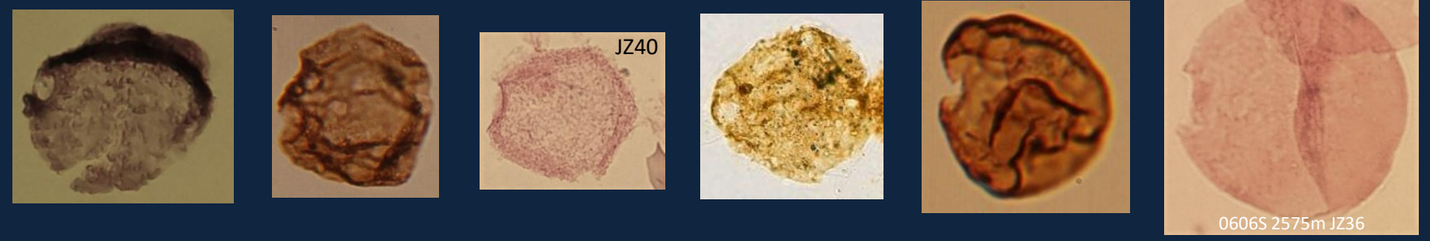


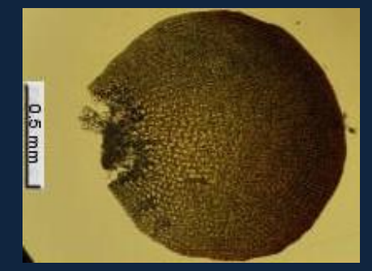

**20µ**



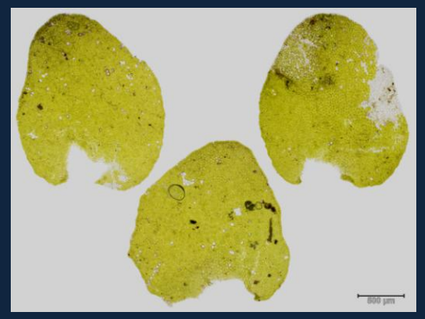

***Sprucianthus planiusuculus***
underleaf .
Siregar et al 2020, Fig. 9


***Frullania incumbens***
leaf
Bluetier.org



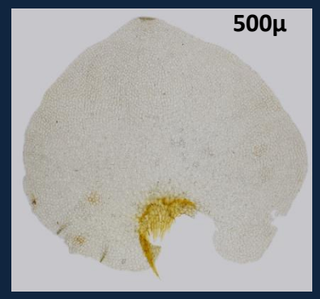




***Jamesoniella colorata***
leaf
Bluetier.org



***Porella platyphylla*** leaves
korseby.net

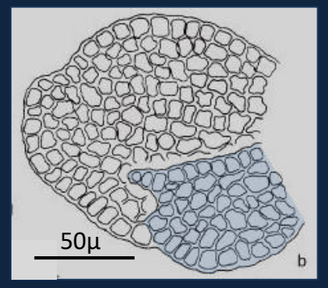
***Porella obtusata***
underleaves & lobules.
Clair Halpin BBS



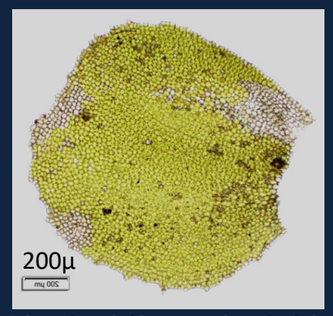

***Scapania uliginosa***
Korseby.net/outer/flora

# Round leaves

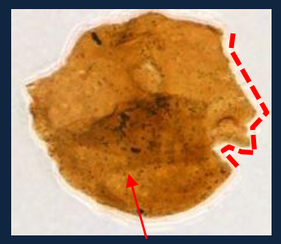
Below and top row of right-hand block: conduplicately bilobed leaves (one lobe folded into the other)

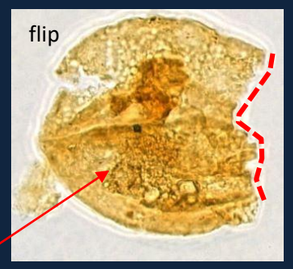


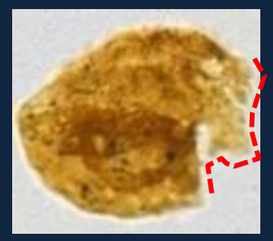

***Lejeunea cardotii***
Bordin & Yano 2009 Fig 12b

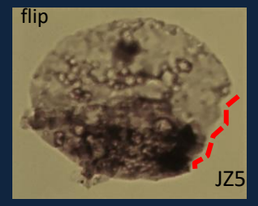



***Plagiochila asplenioides***

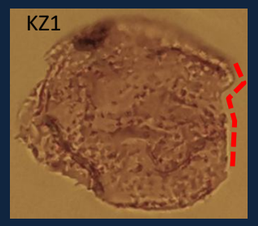

toothed lobule margin



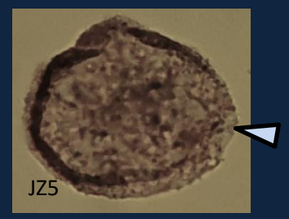


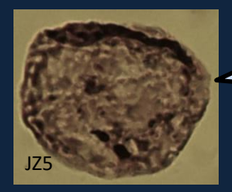






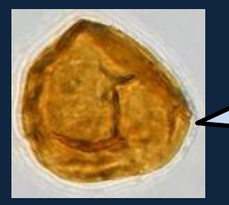
301110A 3619m JZ19

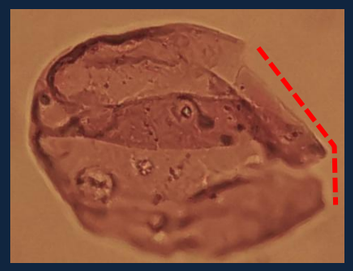


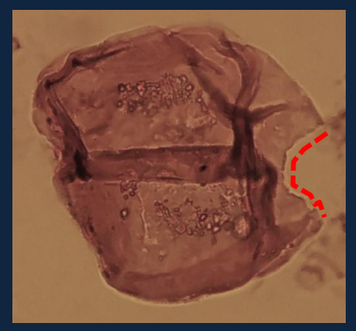





15/5-7 3672m Draupne Fm


25/2-14 3132.25m
base Heather Fm





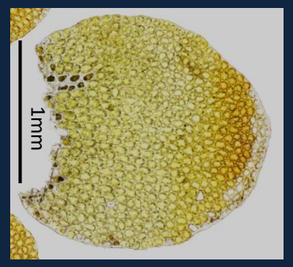

301110A 3619m JZ19

leaf insertion

hole

20µ

# Round leaves




***Mylia anomala***
Korseby.net


***Mylia taylori*** leaf.
Clair Halpin-BBS

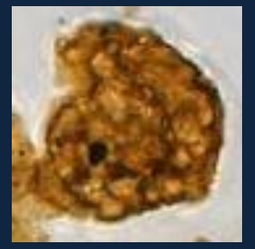
***Jungermannia atroviens***
C. Reisborg/SLU

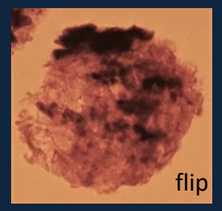

***Plagiochila angusta***
Gradstein & Reeb 2022 fig1E

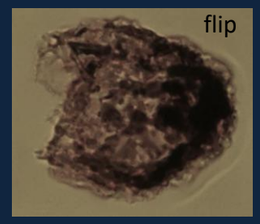


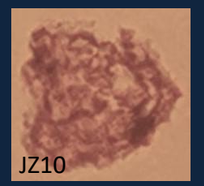
16/2-19 1933.25m
Draupne Fm KZ1-3

30/12-1 2897.5m JZ20

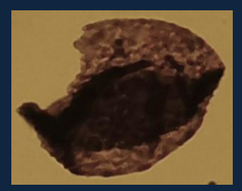


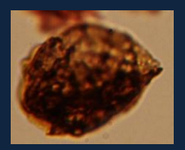




25/8-7 2330.00m
Sleipner Fm

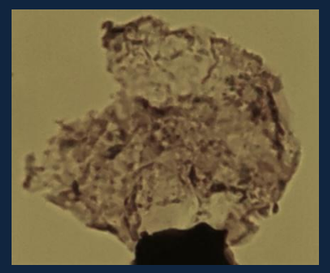


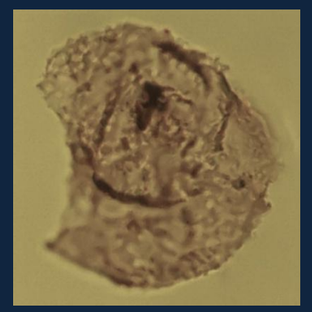




25/2-14 3132.25m
base Heather Fm

20µ

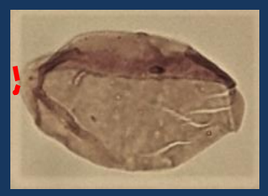


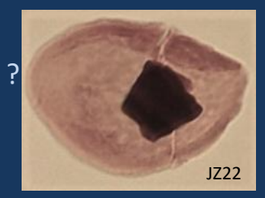





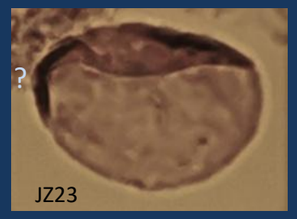
# Lobe or rib?


***Plagioclasa porelloides*** leaf.
H. Tinguy, inpn.mnhn.fr

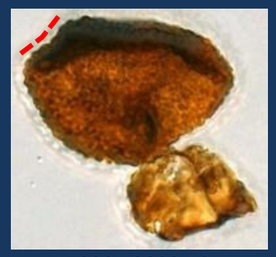









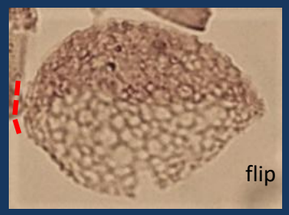

15µ



150201 3802.18m
Hugin



25/2-14 3132.25m
base Heather Fm



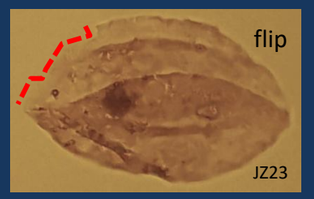
***Jungermannia exsertifolia***
wnmu.edu

# Bi-lobed leaves

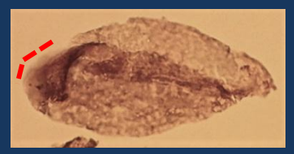

***Douinia ovata*** bilobed leaf
Korseby.net

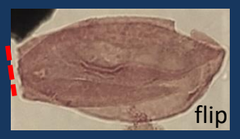




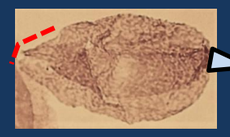




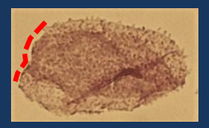








30/12-1 2897.5m.
Heather Fm

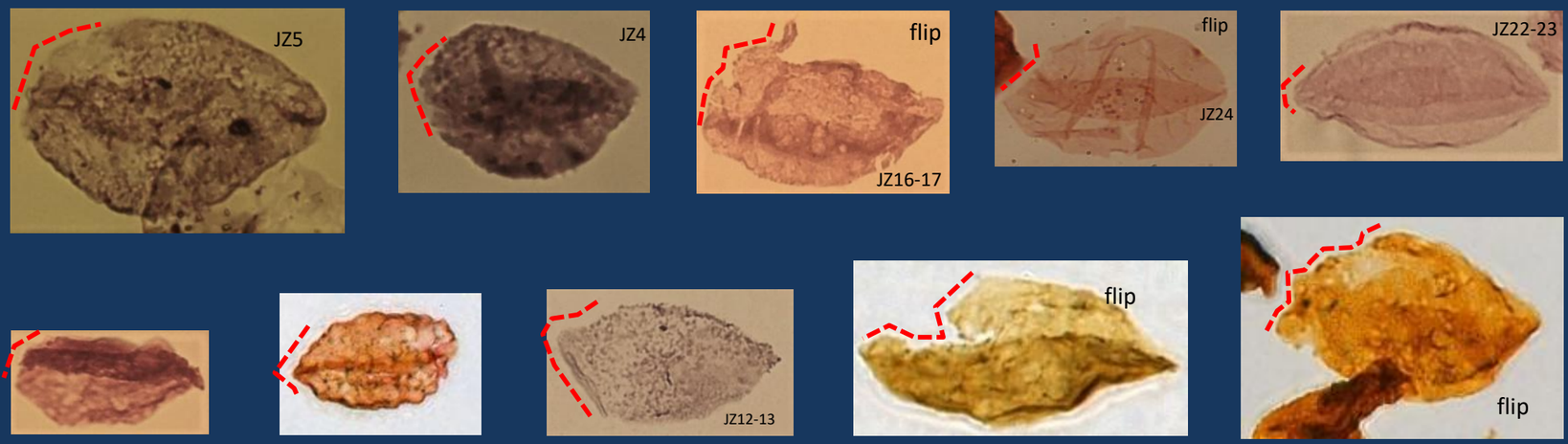


20µ

leaf insertion 

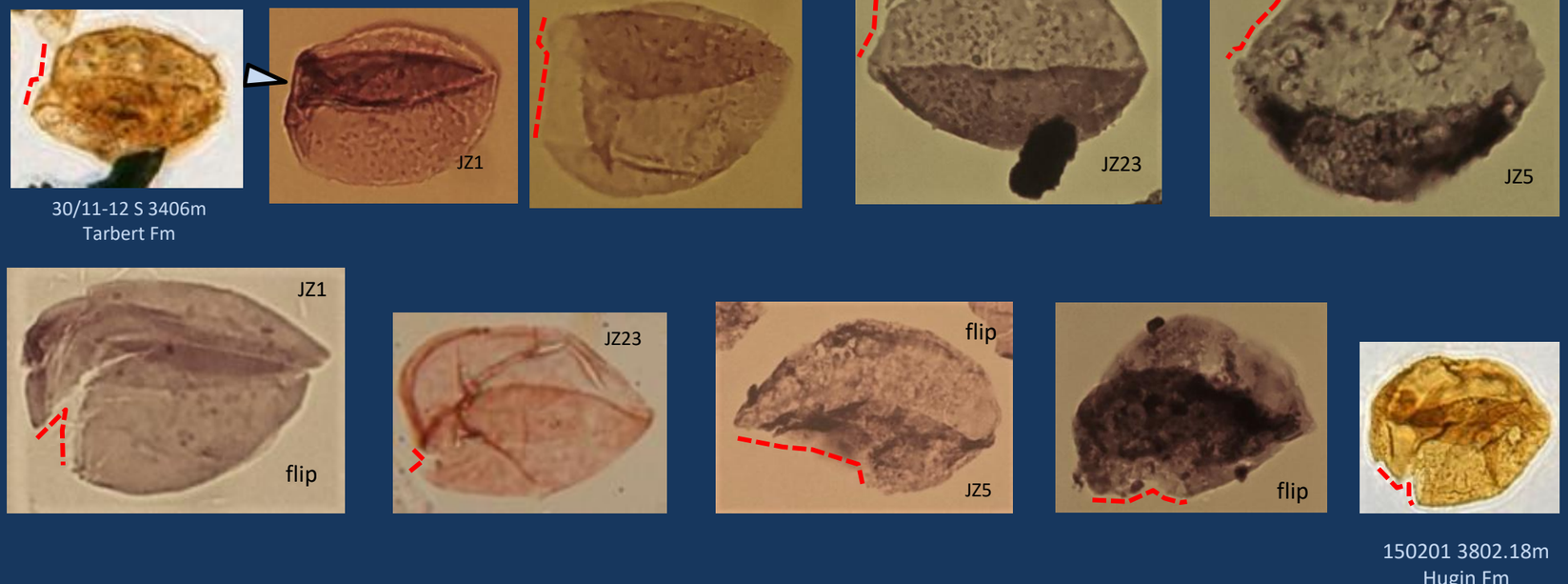
hole 


***Micropterygium carinatum***.
https://plantasdepuertorico.blogspot.com
Ricardo Rico





***Jungermannia sphalera***
Hooker, J.D. 1860
Pl. CLVI



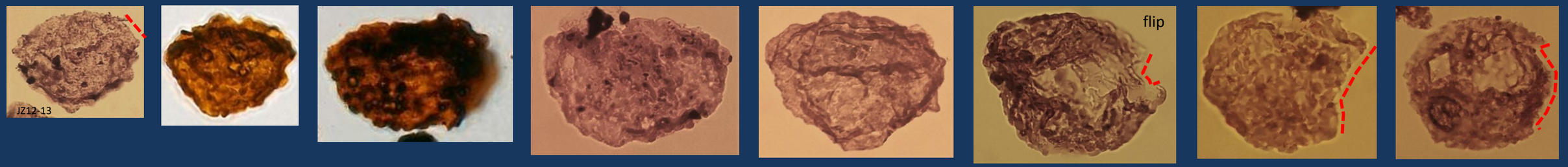

30/11-12 S 3406m
Tarbert Fm

150201 3802.18m
Hugin Fm

leaf insertion

hole

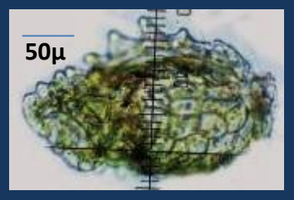
# *Cerebropollenites* – like leaves



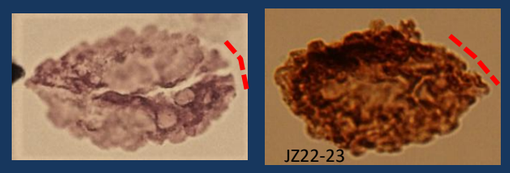

30/11-12A 3848m
Heather Fm

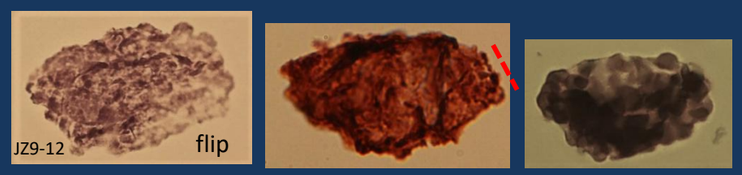
30/11-12A 3848m
Heather Fm


20µ




*Cololejeunea papillosa*
Pocs & Lee 2016 fig 9.13



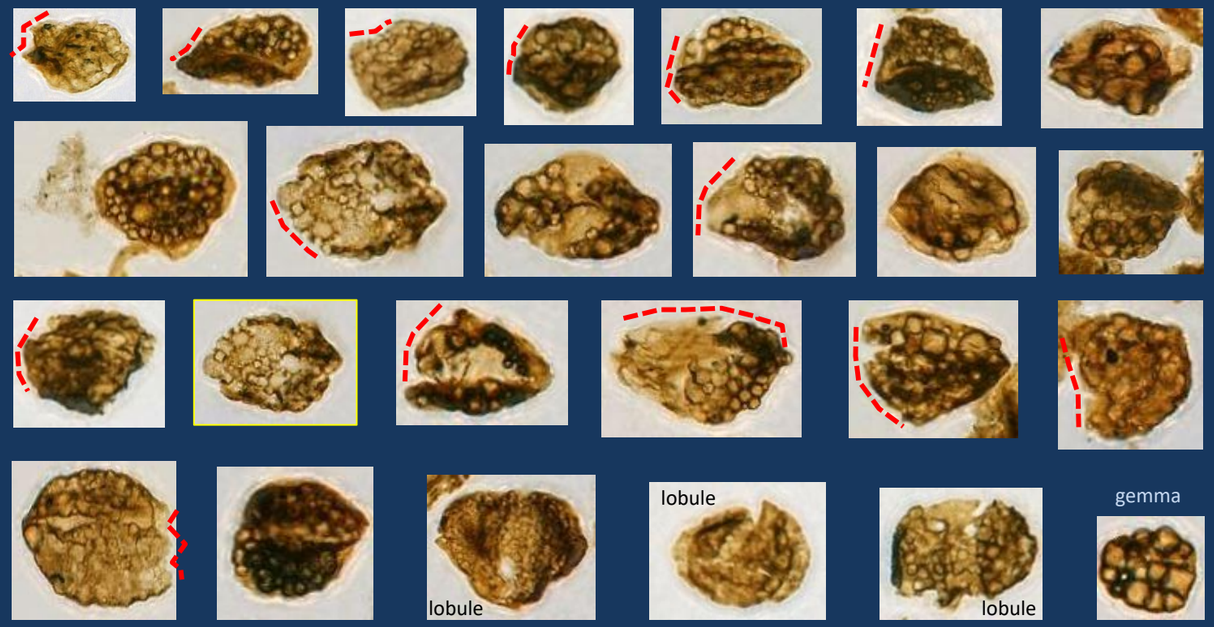




30/12-1 2897.5m.
Heather Fm JZ20ish

30/12-1 2897.5m.
Heather Fm JZ20ish

leaf insertion

# Reticulate leaves




Well 30/12-1 at 2897.5m Middle Bathonian JZ20


***Leptoscyphus cuneifolius*** shoots
(for broad comparison only).
southappalachianbryophytes.org

50µ

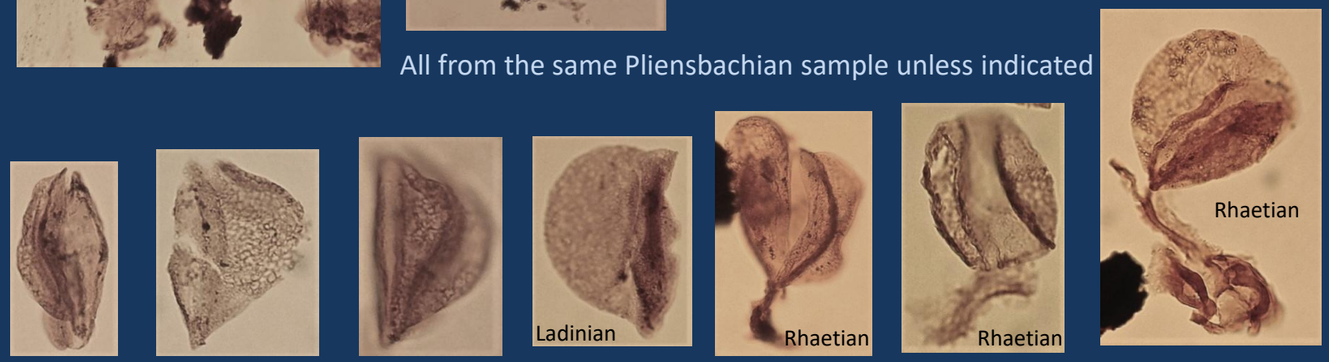

Well 25/2-14 at 3132.75m  Mid Bathonian JZ20

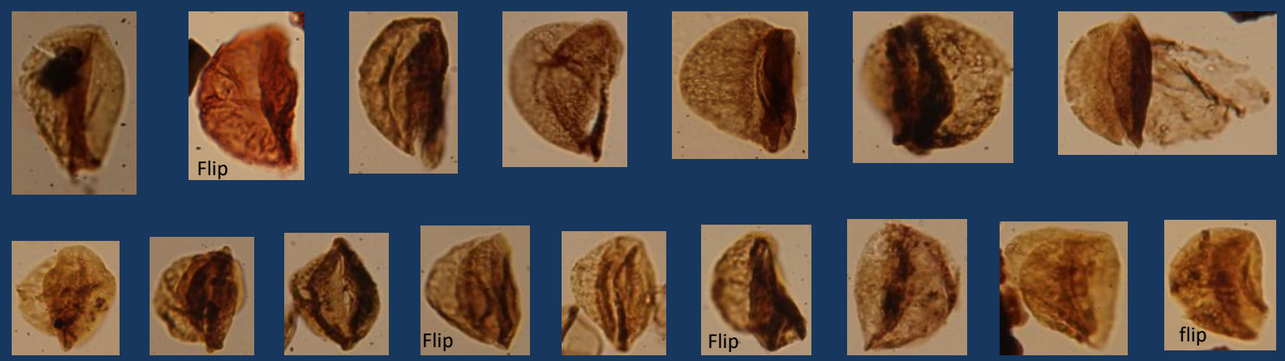
Selected from both sets and
arranged on mock-up thallus

# “Bisaccate leaves”


All from the same Pliensbachian sample unless indicated

50µ



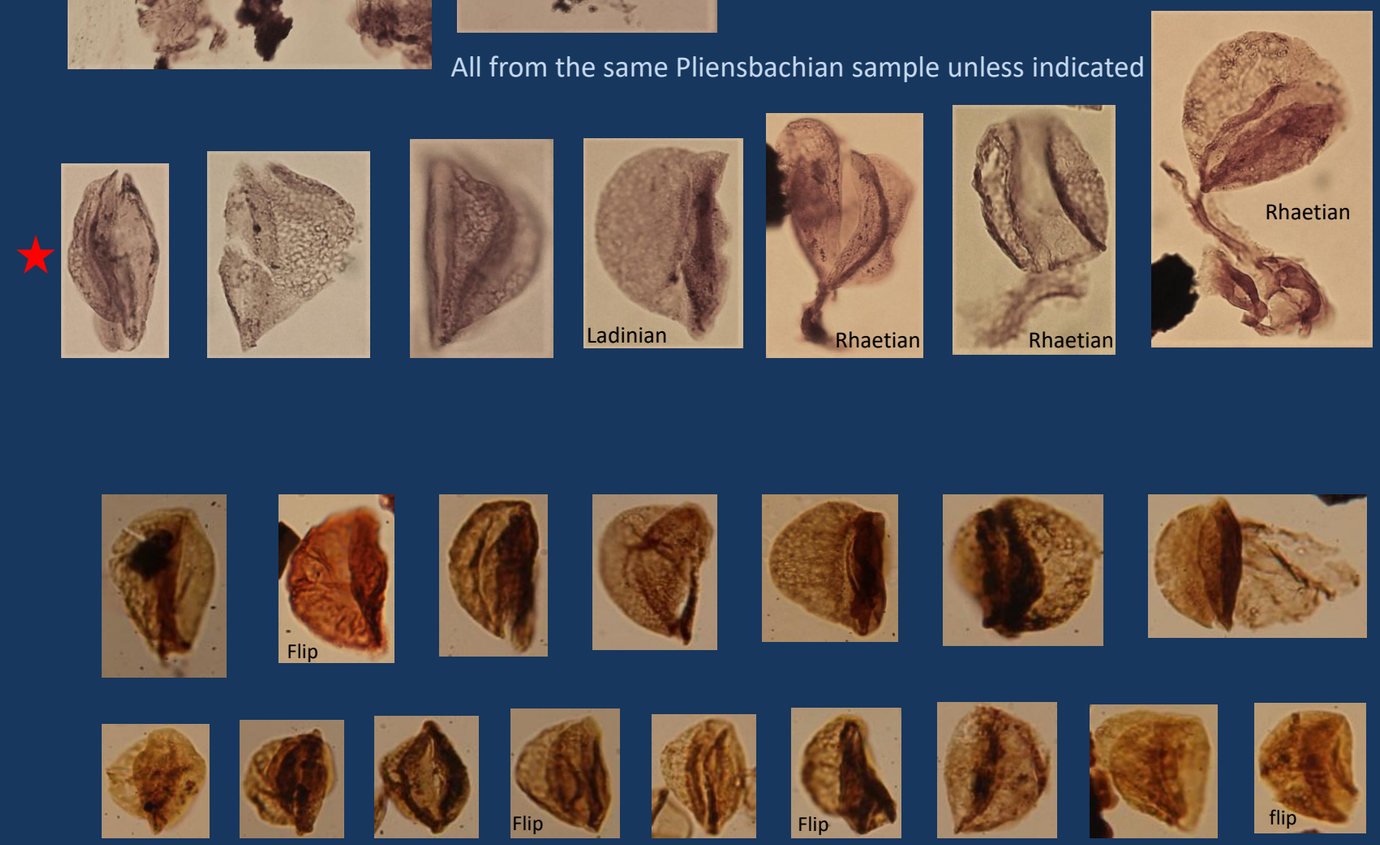




Mid Jurassic JZ20-23 SVG

# “Bisaccate leaves”


All from the same Pliensbachian sample unless indicated

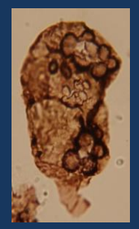
50µ

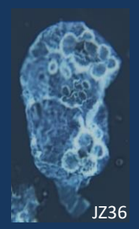



Mid Jurassic JZ20-23 SVG

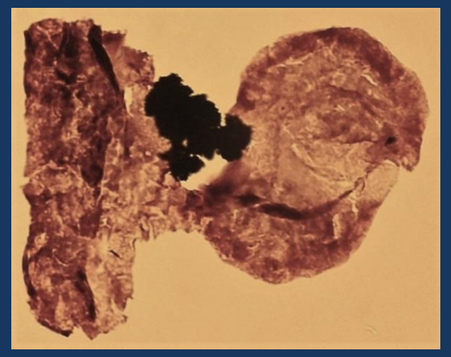
***Myrmylia anomala*** shoot

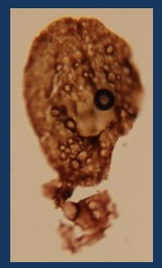
# Lobules, not bisaccate pollen

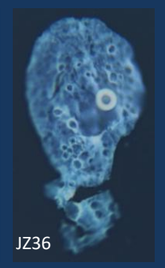



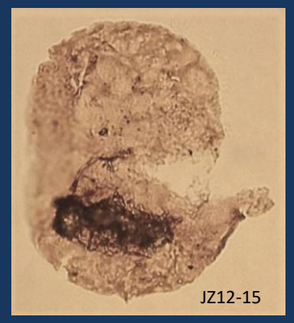



50µ



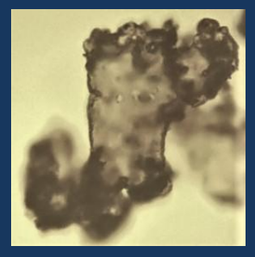




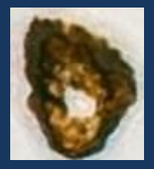




***Frullania vaginata***
lobule
Uribe 2011 from Fig. 1 D

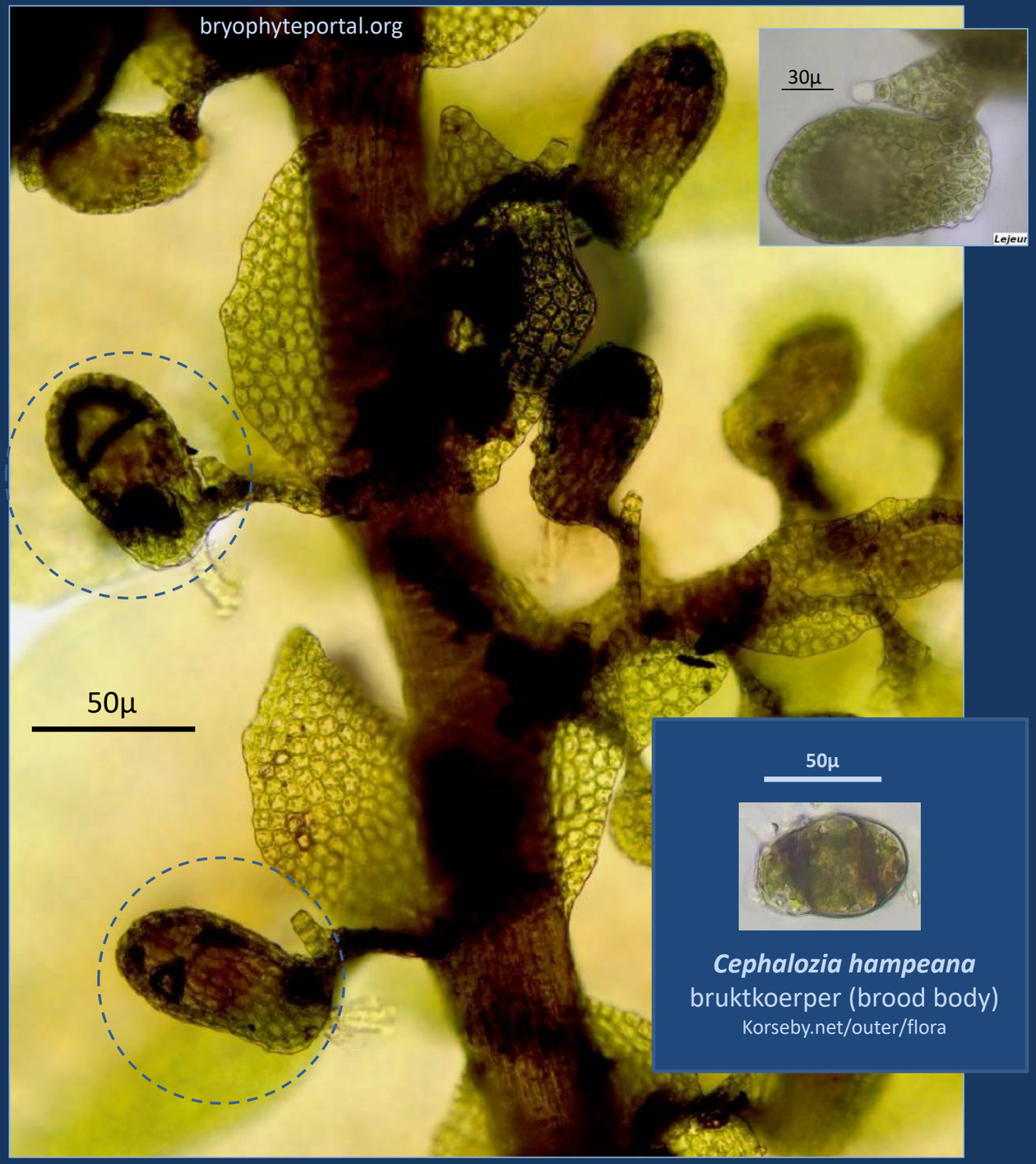




***Frullania inflata***
lobule
*wnmu.edu*

***Lejeunea* sp. lobule**
Bluetier.org



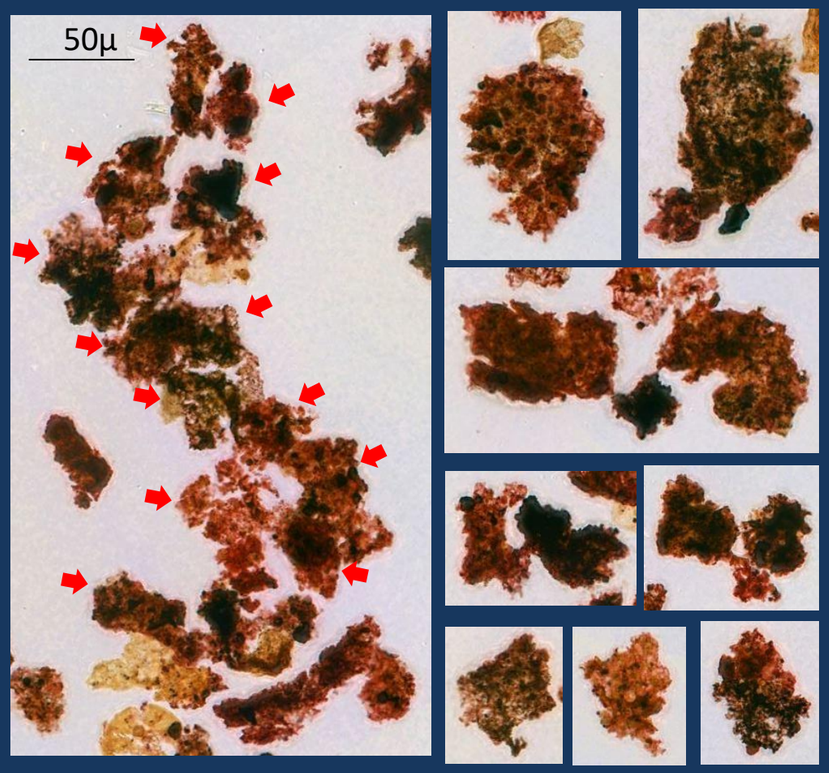

50µ



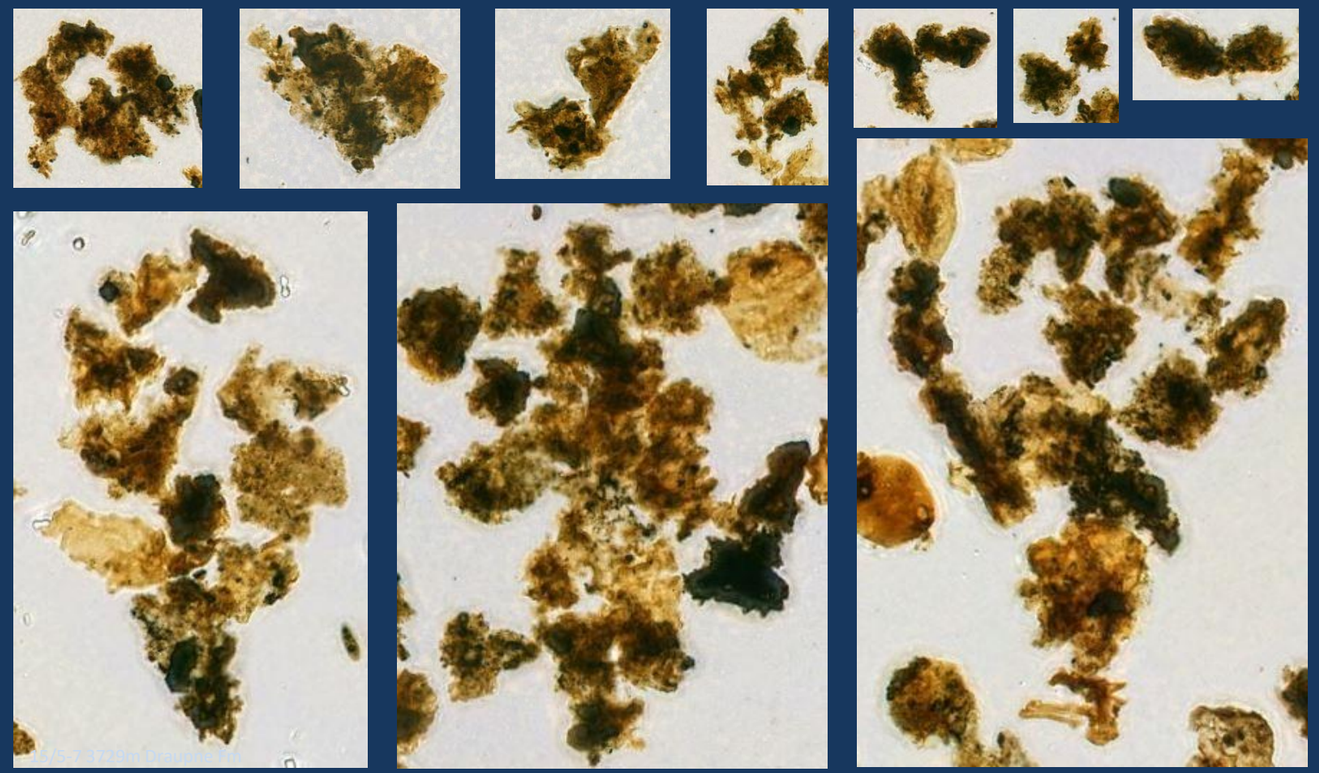
***Cephalozia hampeana***
bruktkoerper (brood body)
Korseby.net/outer/flora

***Frullania obcordata*** ventral view
Uribe 2011 from Fig. 1 D

# Pseudoamorphous leaves

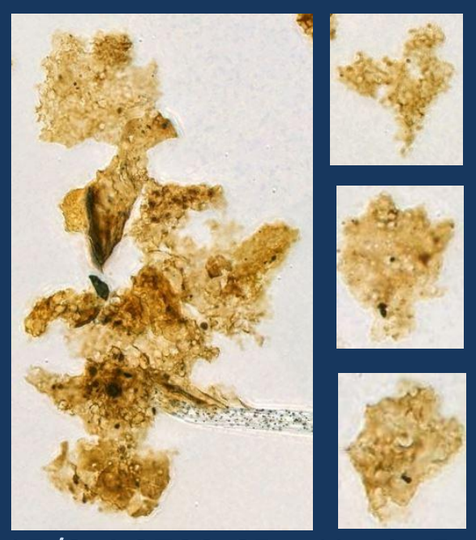



7228/2-1 1095.0m  Kolmule Fm



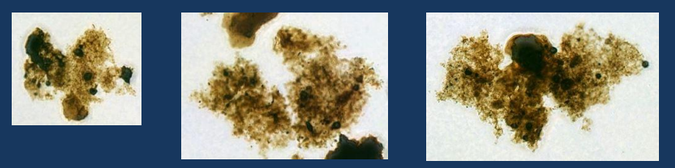
15/5-7 3729m Draupne Fm

50µ

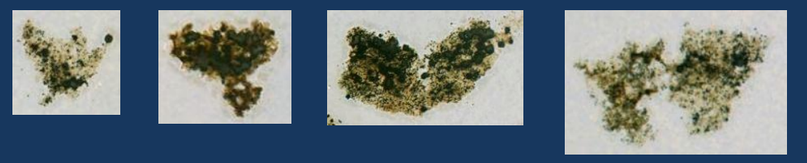


15/3-4 3792.65m Hugin Fm

25/2-16 S 3942m
Sleipner Fm

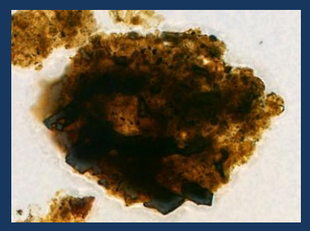
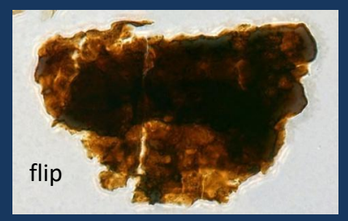


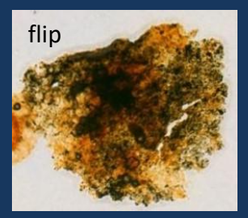
7220/11-1 1851.0m
Snadd Fm

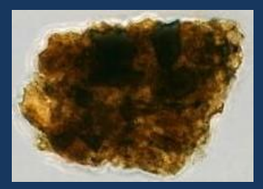
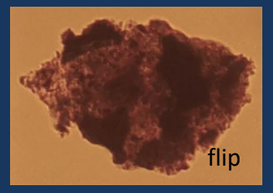


7323/7-U-11  98.75m
Permian

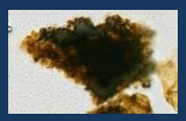
# “Phytoclast-like” leaves

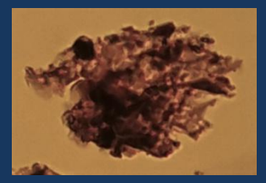
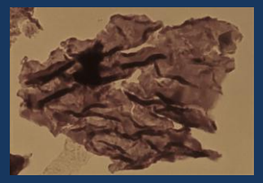
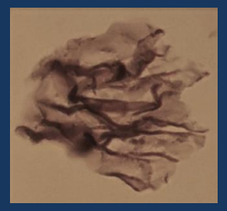



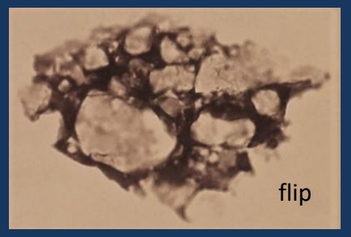


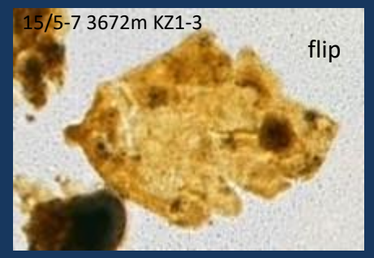





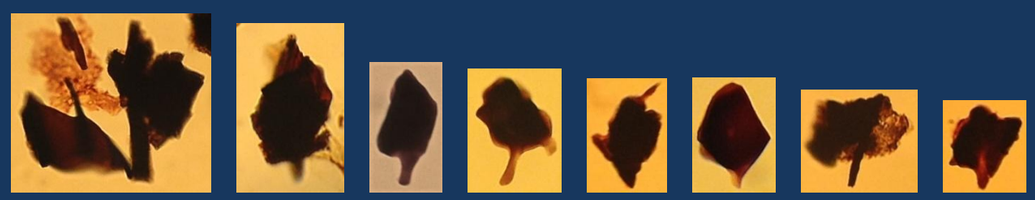
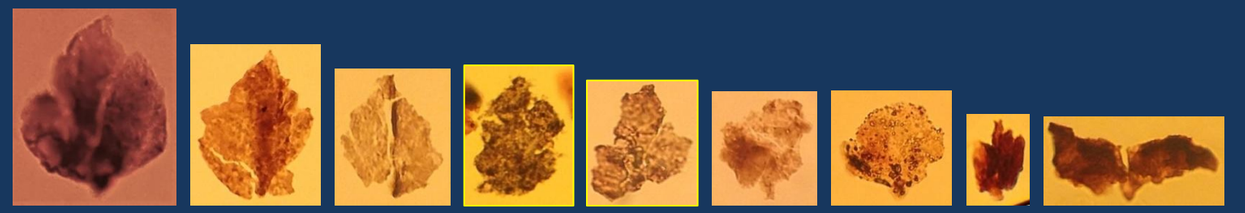



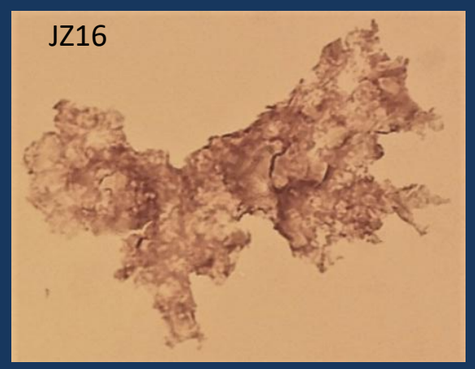




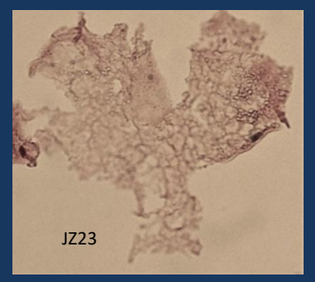



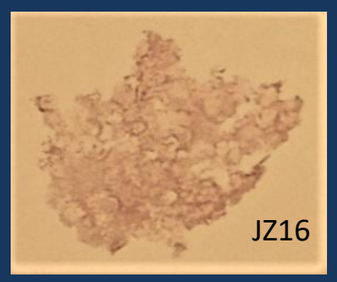


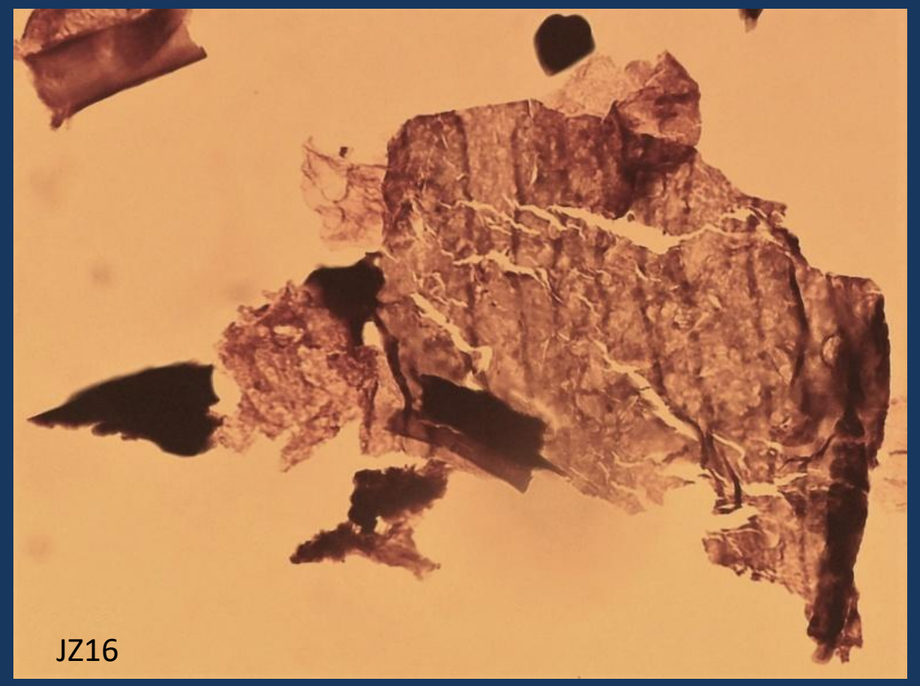

30µ

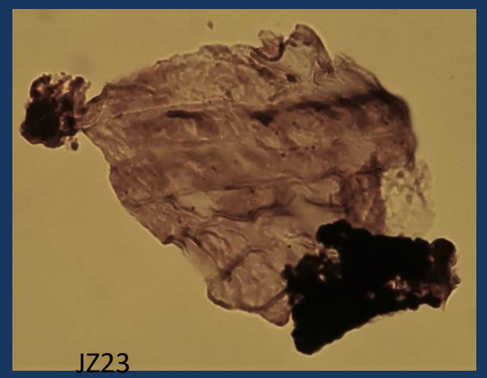



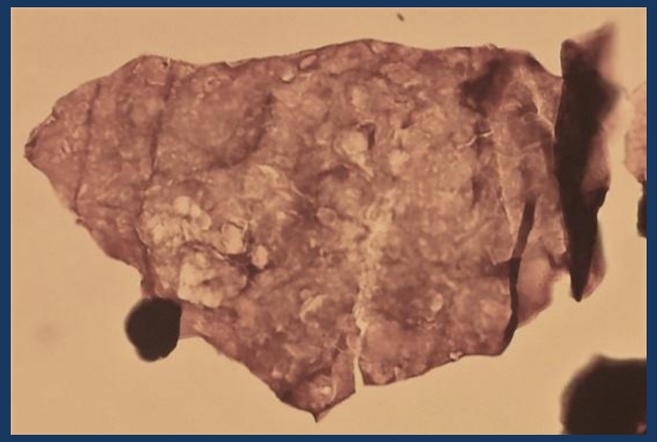




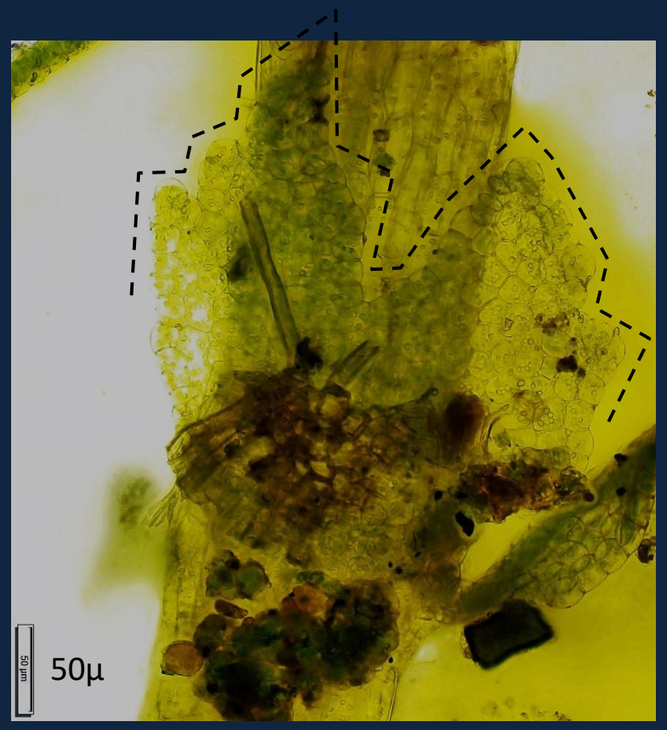






# petaloid leaves/underleaves

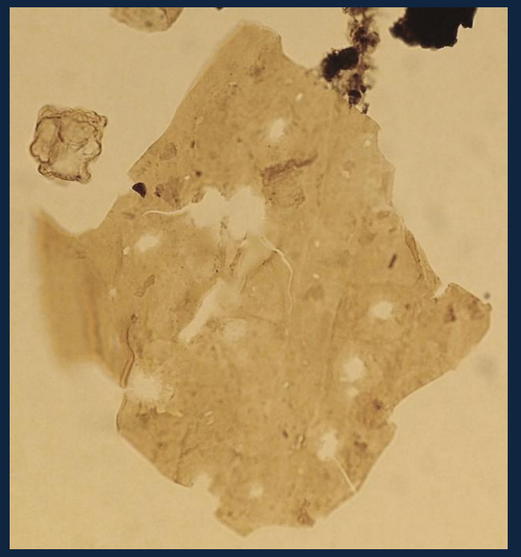


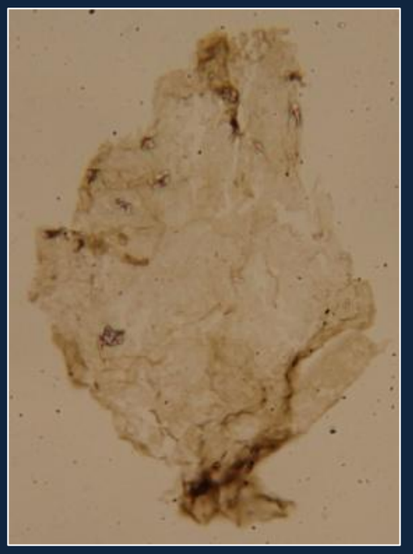

***Frullania brittoniae*** underleaf
https://wnmu.edu/academic/nspages/gilaflora



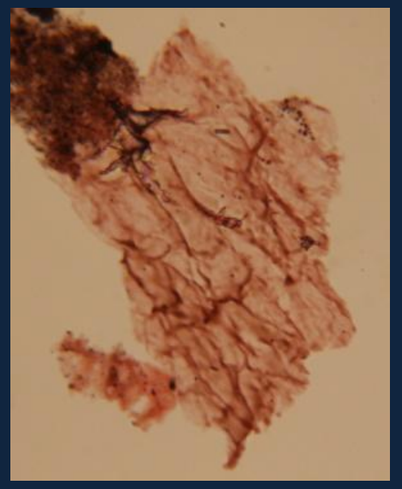


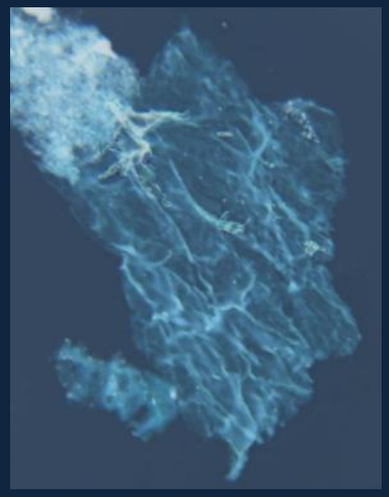


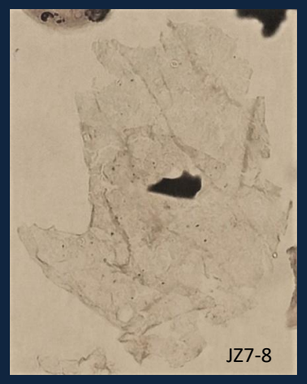



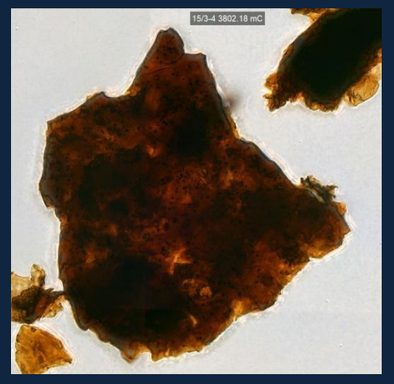


50µ



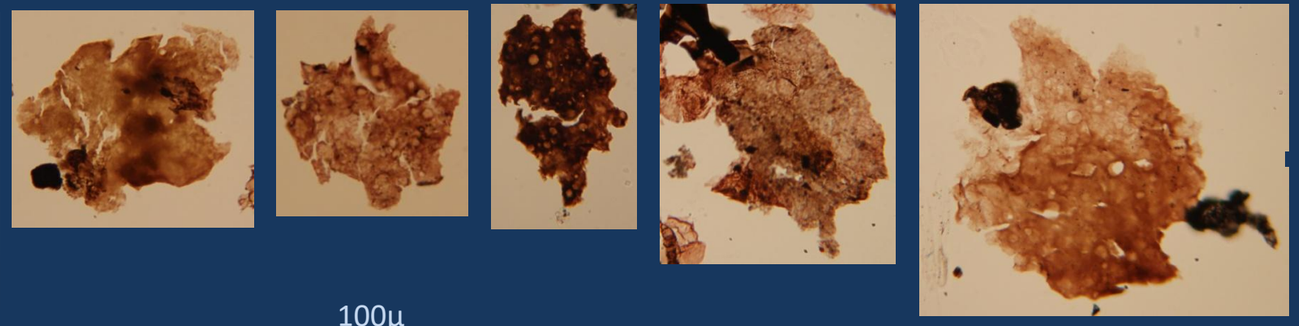




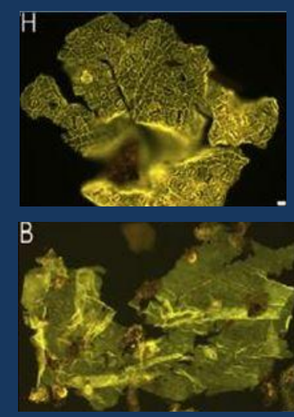




## Underleaves of Jurassic Frullaniaceae

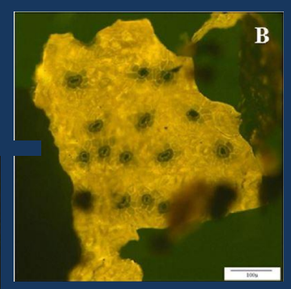

www.discoverlife.org photo: Matt von Konrat



100µ




Gadens-Macon *et al* 2014, Figs 7B, 7H
(membrane & cuticle)




Goncalves et al 2015 Fig 4B
(cuticle)

# *Et tu, Brute?*

*N. gracilis* holotype

All other specimens except ★ are from the same Late Pliensbachian sample, SVG

50µ

leaf insertion

stipule/hole

Associated with a variety of similar forms, many with attached bodies, some in pairs;
not quite *Nannoceratopsis*

Not certain about this one, but very suspicious!

Especially with

3 mm

leaves with attached bodies (black circles)

leaf “pair” (blue circle)


***Plagiochila exigua*** shoot. Clair Halpin-BBS

***Plagiochila exigua*** southappallachianbryophytes.org

# Discussion

- Our current interpretation of Jurassic miospore assemblages is very narrow, with remarkably few plant species.....where are the mosses and liverworts?

- Supporting evidence from other parts of the plant in the same material

- Bryophytes are uncommon as macrofossils.

# Discussion

- Palaeoenvironmental models: Abbink *et al.* Ecogroups based on *in situ* pollen & spores from macrofossils, but the much of the data entered is inaccurate.

- Jurassic bias, plus some M-L Triassic & earliest Cretaceous. *Avatara* ; also seem to be abundant in the Cretaceous.

- Review of photographic collections and literature suggests liverwort leaves are also present in palynological samples from the Palaeozoic


***Tauticaulis*** sp. Devonian, UK.
from Fig. 4 in Morris et al YEAR?
(reoriented).

# Conclusions

- Leaves and other leaf-like bodies of liverworts are abundant and widespread in palynological and palynofacies samples from Mesozoic sediments of northwest Europe.

- Our current model for the interpretation of Mesozoic miospores does not reflect the diversity of plant life in these ancient ecosystems.

- Implications are significant for palynology, requiring a re-evaluation of the biological affinities of numerous taxa.

- Study and interpretation of this material requires greater integration of palynology with botany/palaeobotany.