

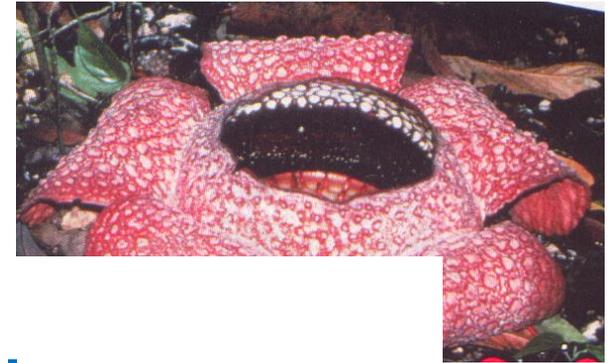
NOVIDADES REPRODUTIVAS DAS ESPERMATÓFITAS ANGIOSPERMAS

Prof. José Rubens Pirani



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Objetivos:

Analisar as sinapomorfias do grupo, sobretudo as reprodutivas, com ênfase nos atributos que podem estar relacionadas ao seu grande sucesso na natureza.



ANGIOSPERMAS = plantas floríferas -- fruto

urna semente



Clusia
CLUSIACEAE



Magnolia grandiflora

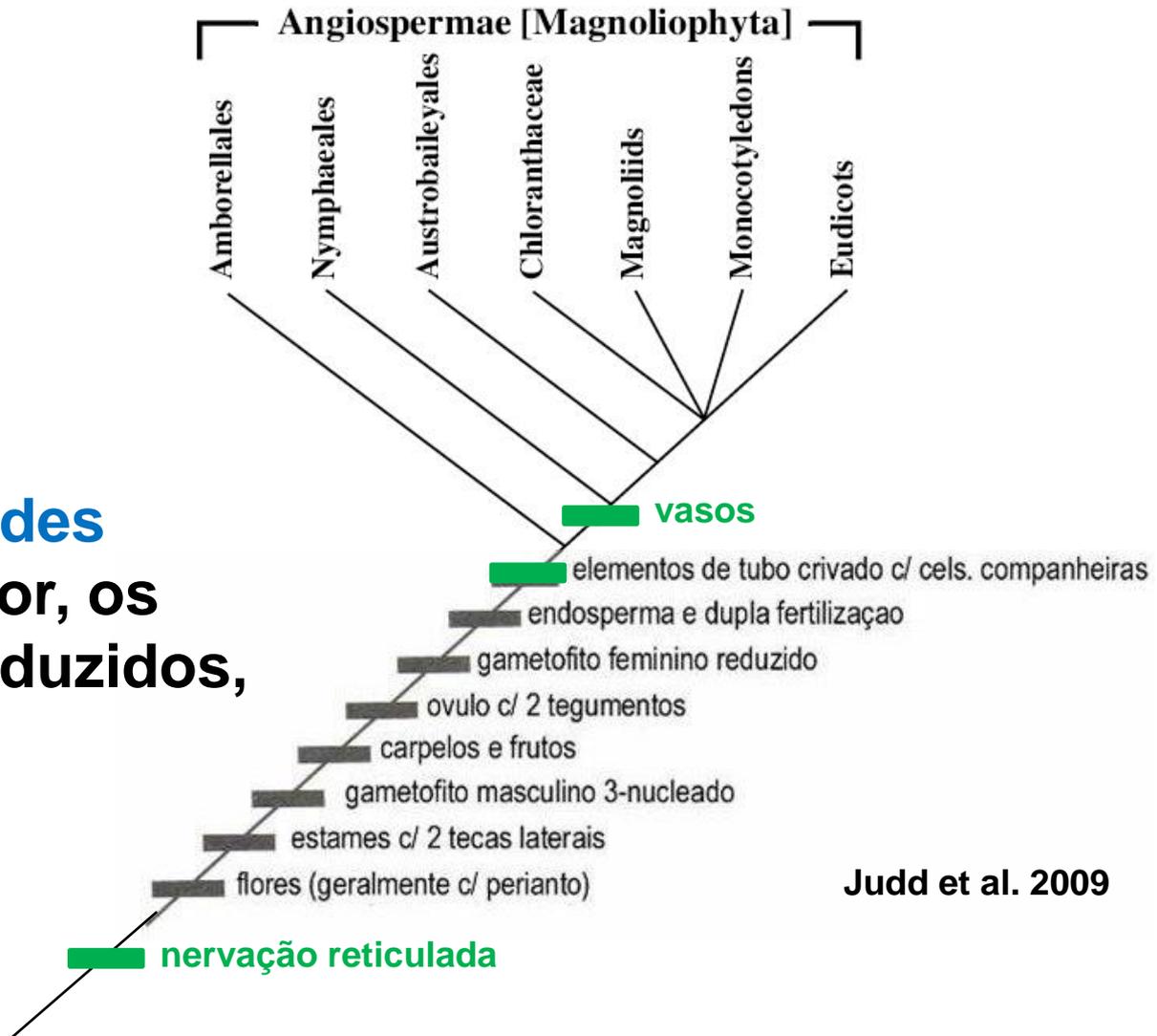
Filo ANTHOPHYTA ou MAGNOLIOPHYTA

❖ Angiospermas:

Grupo monofilético

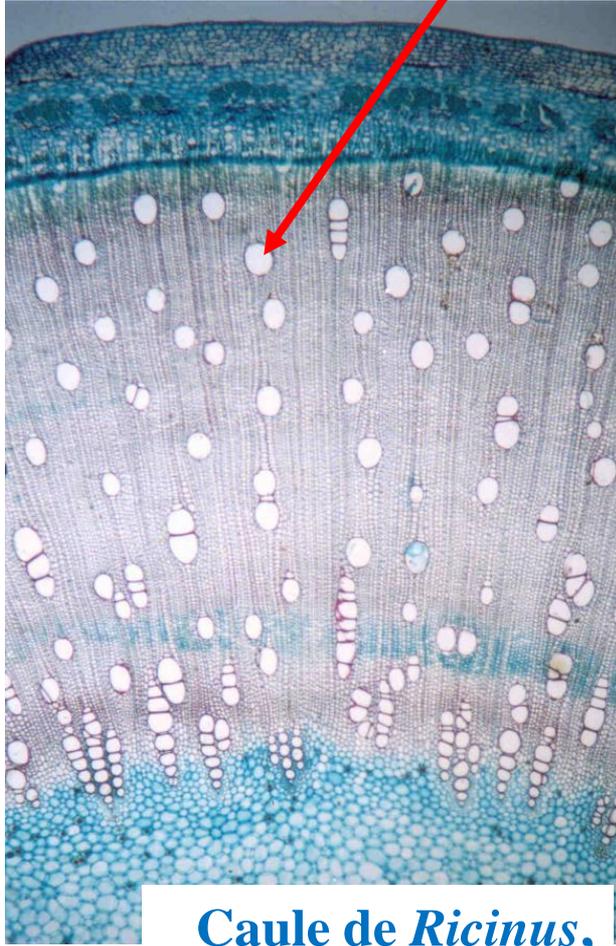
❖ **Sinapomorfias**
(muitas delas **novidades evolutivas**, como a flor, os gametófitos muito reduzidos, o carpelo, o fruto e o endosperma)

■ **Sinapomorfias vegetativas**



Angiospermas - Sinapomorfias

Xilema: vasos



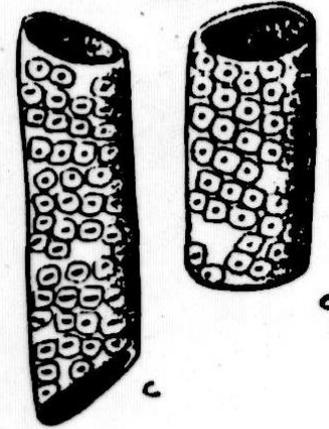
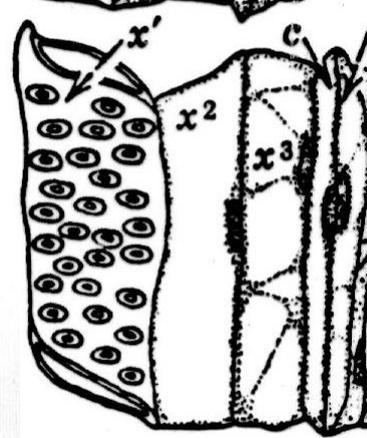
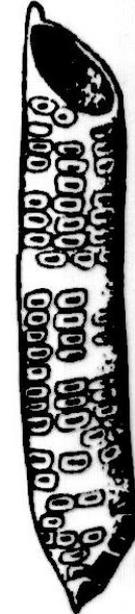
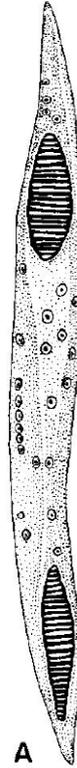
Caule de *Ricinus*,
Euphorbiaceae

Elemento de vaso
de *Gnetum*,
gimnosperma

Stewart & Rothwell 1993

Convergência

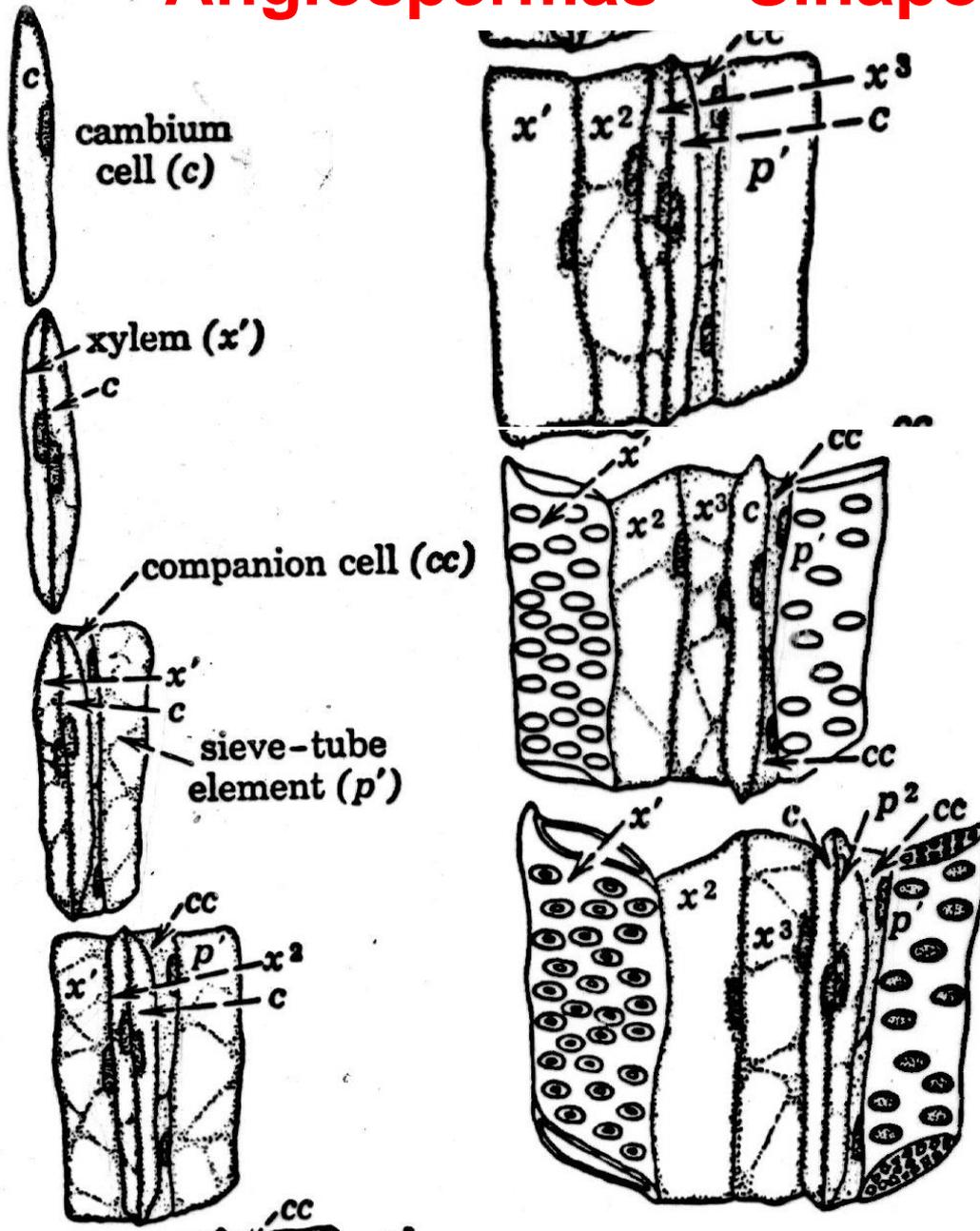
elementos
de vaso



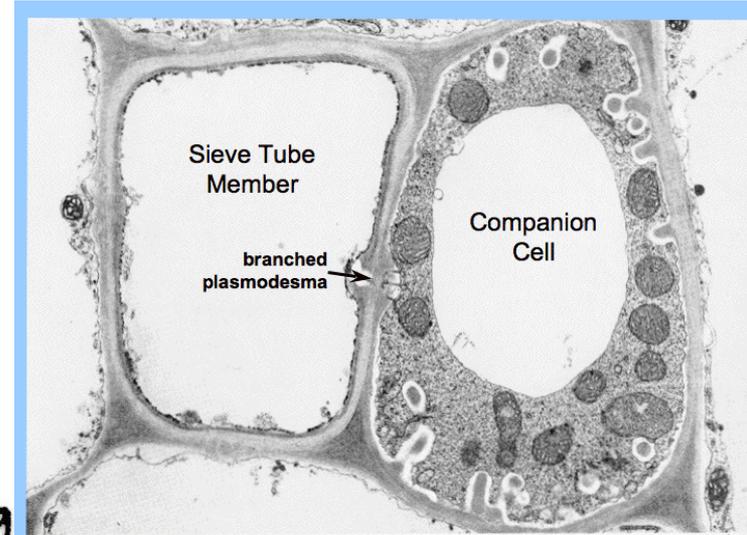
Robbins & Weiser 1950

Gifford & Foster 1996

Angiospermas - Sinapomorfias



Floema:
Elementos de tubo
crivado anucleados +
células companheiras

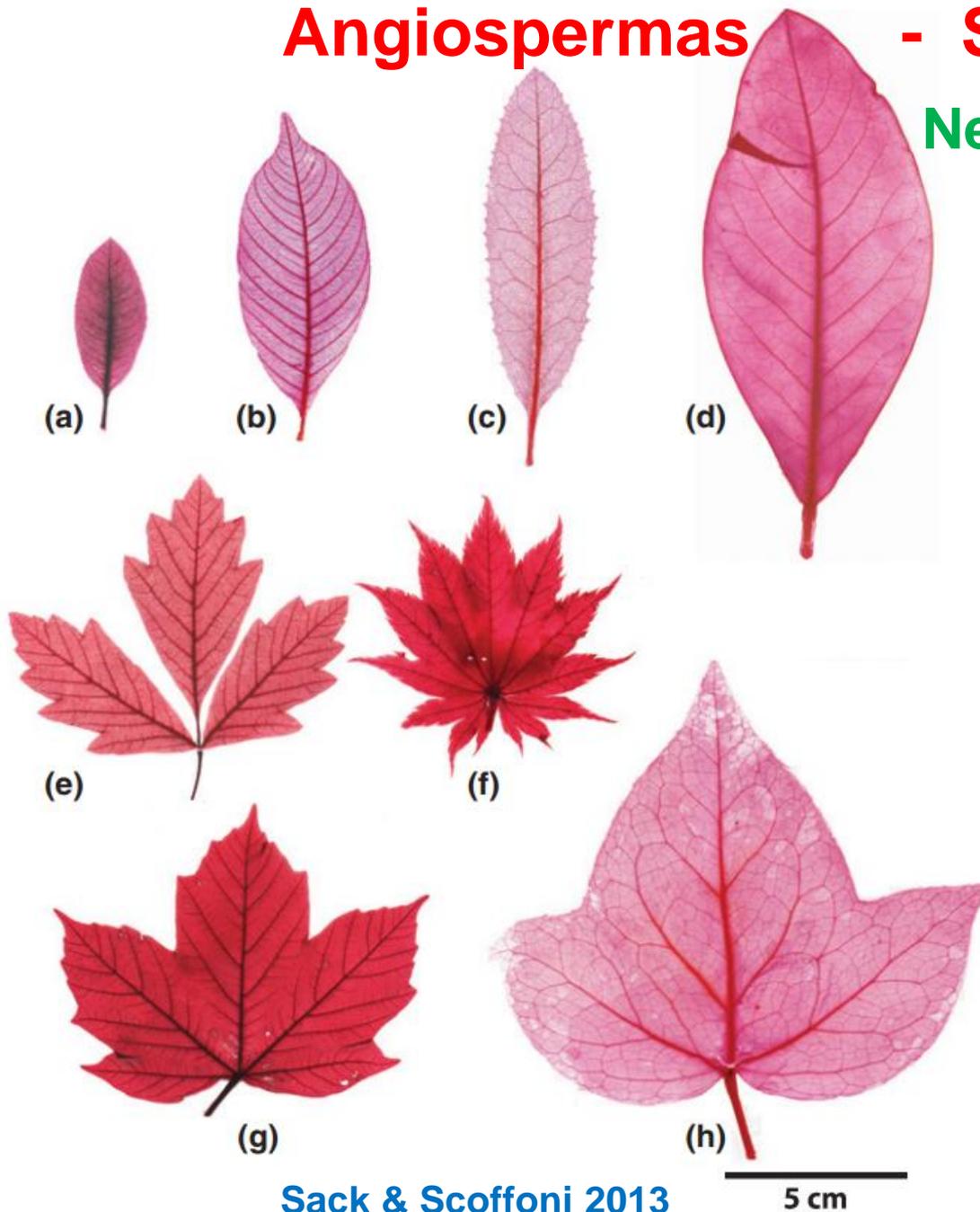


©2002 Sinauer Associates

Robbins & Weiser 1950

Angiospermas - Sinapomorfias

Nervação foliar reticulada



Sack & Scoffoni 2013

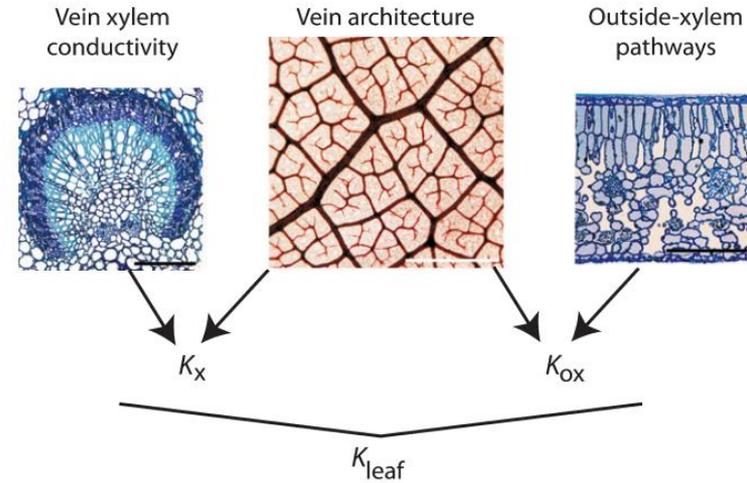


Fig. 3 Determinants of leaf hydraulic conductance (K_{leaf}): K_{leaf} can be partitioned into two components: the hydraulic conductance of the vein xylem (K_x) which is determined by the vein xylem conductivities and vein lengths per unit area (VLA) of the different vein orders, and the hydraulic conductance outside the xylem (K_{ox}), which is determined by the VLA and cellular and biochemical properties of the living tissues outside the xylem. Higher VLA and wider and more numerous xylem conduits will increase K_x and thus K_{leaf} , while higher VLA will also increase K_{ox} by reducing the distance for water to move from the xylem to the site of transpiration, and K_{ox} will also be increased by the permeability of cells and cell walls in the pathway of water movement through the mesophyll. From left to right: midrib cross-

Fig. 1 Diversity in angiosperm leaf vein systems visible in chemically cleared leaves, emphasizing leaf vein tapering, major vein length per unit area, vein topology and leaf size. (a) *Comarostaphylis diversifolia*: simple pinnate leaf with brochidodromous secondary (second-order) veins. (b) *Trichilia elegans*: simple pinnate leaf with eucamptodromous second-order veins. (c) *Heteromeles arbutifolia*: simple pinnate leaf with brochidodromous second-order veins. (d) *Magnolia grandiflora*: simple pinnate leaf with brochidodromous second-order veins. (e) *Acer griseum*: compound pinnate leaf with craspedodromous second-order veins. (f) *Acer japonicum*: simple palmate leaf with craspedodromous second-order veins. (g) *Acer diabolicum*: simple palmate leaf with craspedodromous second-order veins. (h) *Hedera canariensis*: simple palmate leaf with brochidodromous second-order veins. In (a–d), note that larger-leaved species have major veins spaced further apart, and declining major vein length per unit area.

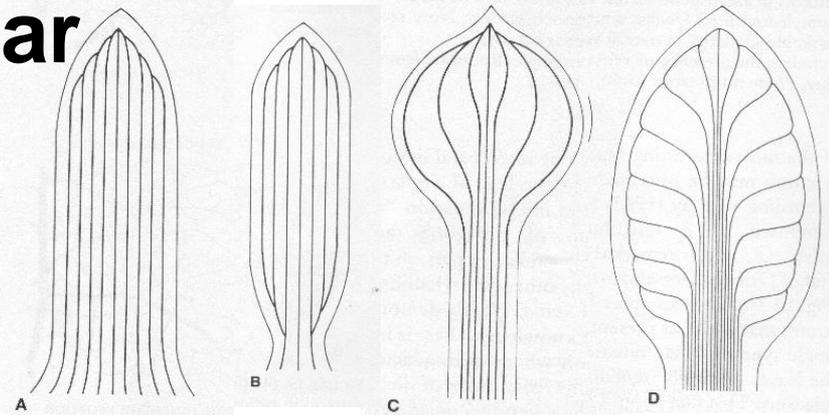
GIMNOSPERMAS



Abies, Pinaceae
Uninérvea ou dicotômica

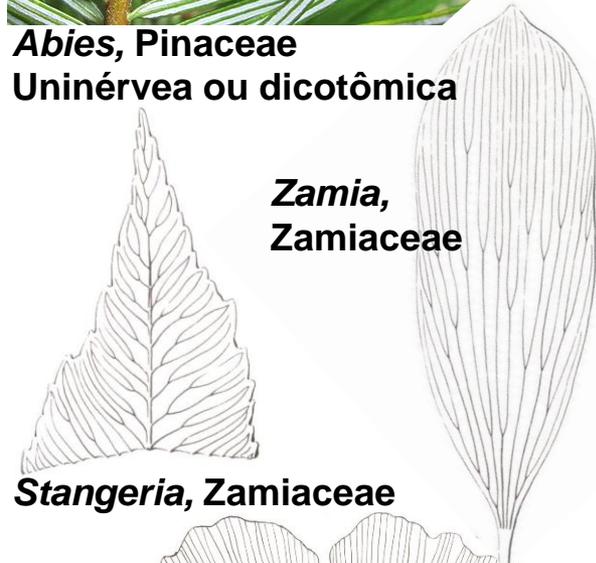
Nervação foliar

Paralelinérvea
Nervuras
paralelas
de mesmo
calibre

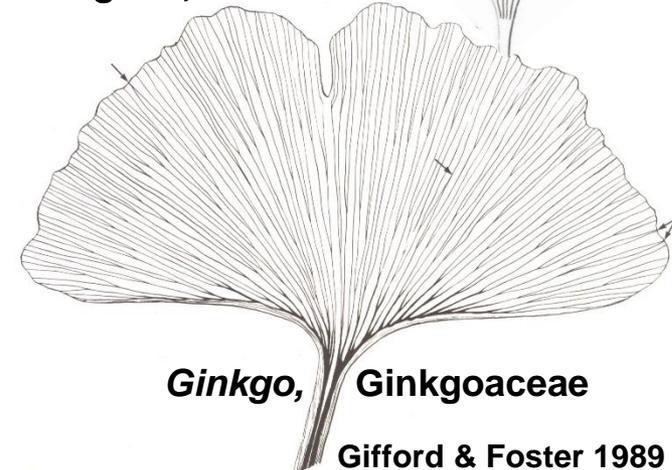


ANGIOSPERMAS MONOCOTILEDÔNEAS

Zamia,
Zamiaceae



Stangeria, Zamiaceae



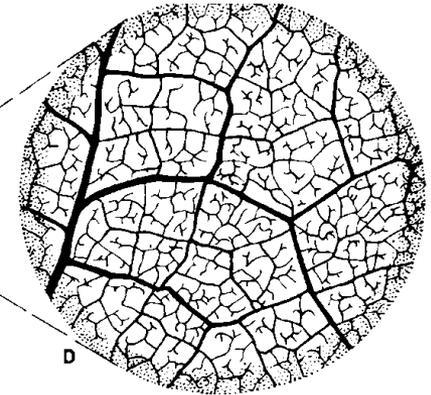
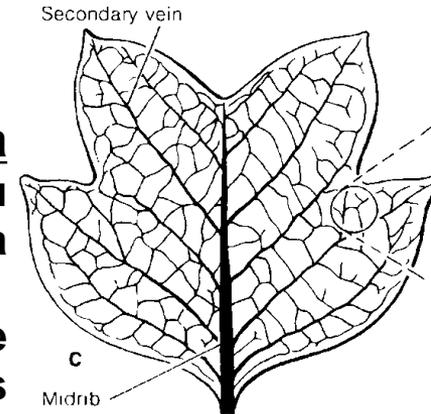
Ginkgo, Ginkgoaceae

Gifford & Foster 1989

MAIORIA DAS ANGIOSPERMAS

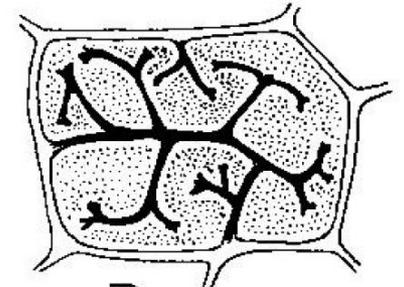
Reticulada
ou
reticulínérvea

Nervuras de
vários
calibres,
retículos
densos
e com
terminações
livres



Liriodendron,
Magnoliaceae

Pray (1954, 1955)



NOVIDADES EVOLUTIVAS de ANGIOSPERMAS

jatobá
Hymenaea stigonocarpa
Leguminosae

FLOR:

Eixo caulinar contraído com
folhas modificadas e esporângios



VERTICIOS florais (ou ciclos florais): cálice, corola androceu e gineceu.

jatobá
Hymenaea stigonocarpa

FLOR: Eixo caulinar contraído com
folhas modificadas e esporângios

folhas modificadas

Sépala (cálice)

Pétala
(corola)

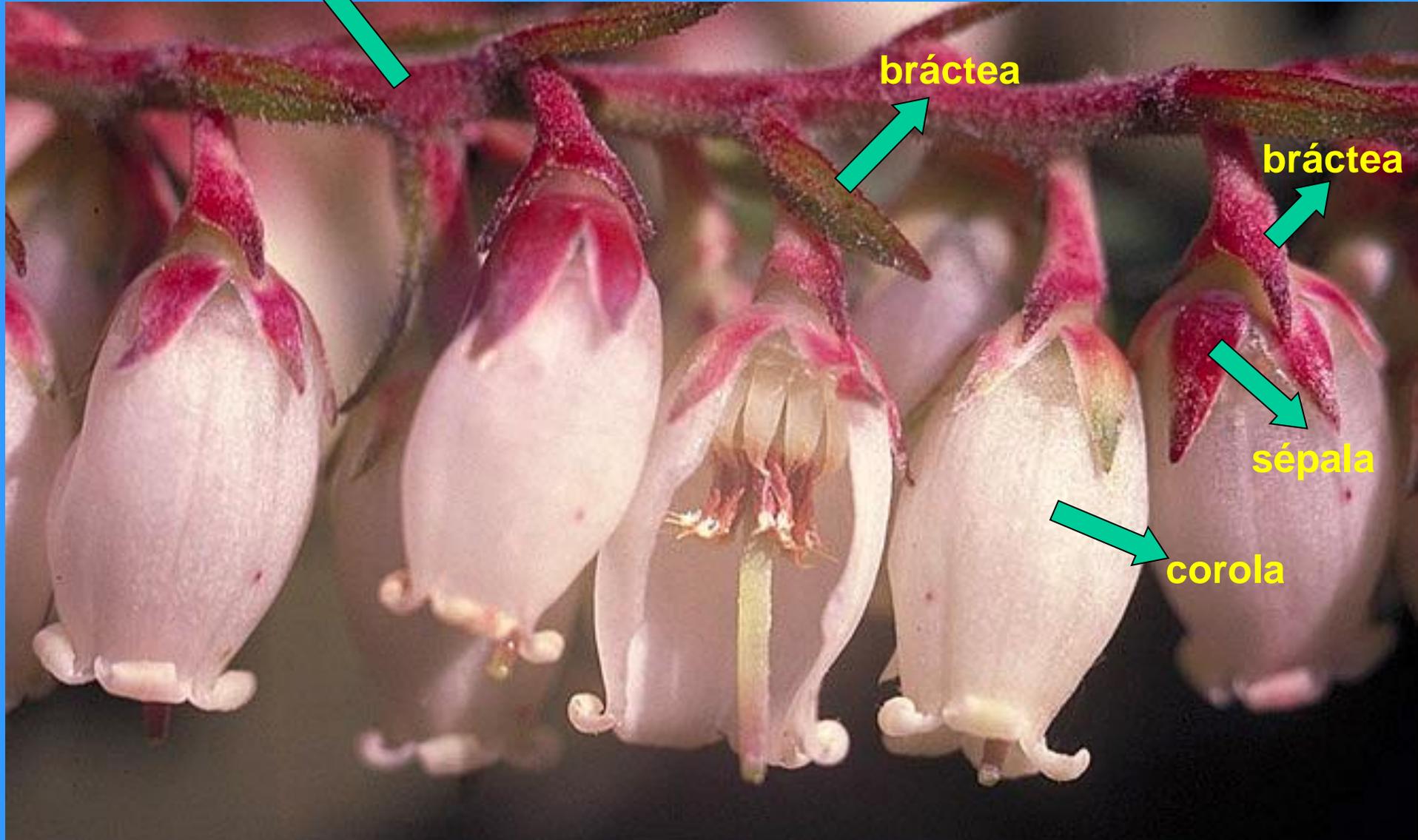
Estame
(androceu)

Gineceu



Notar na vista frontal da flor aberta a **disposição verticilada** das peças florais, também evidenciada pelas cicatrizes das peças já caídas na flor da direita.

eixo da inflorescência (ramo caulinar com folhas modificadas em brácteas, as quais sustentam flores em suas axilas)



bráctea

bráctea

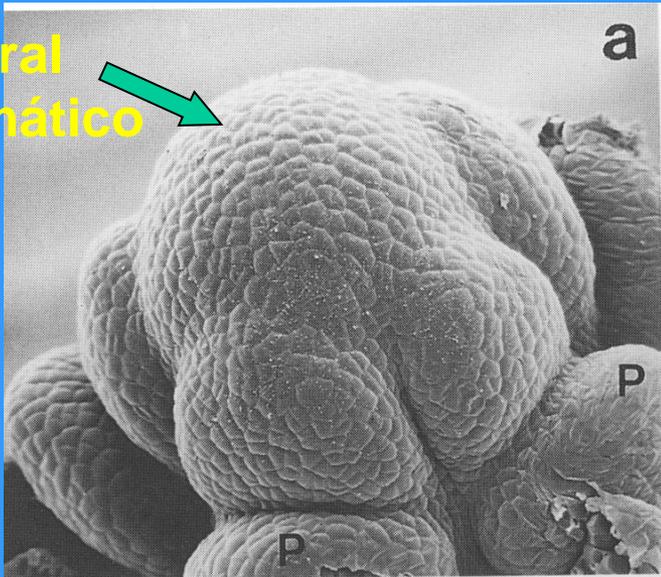
sépala

corola

Ontogenia e desenvolvimento floral:

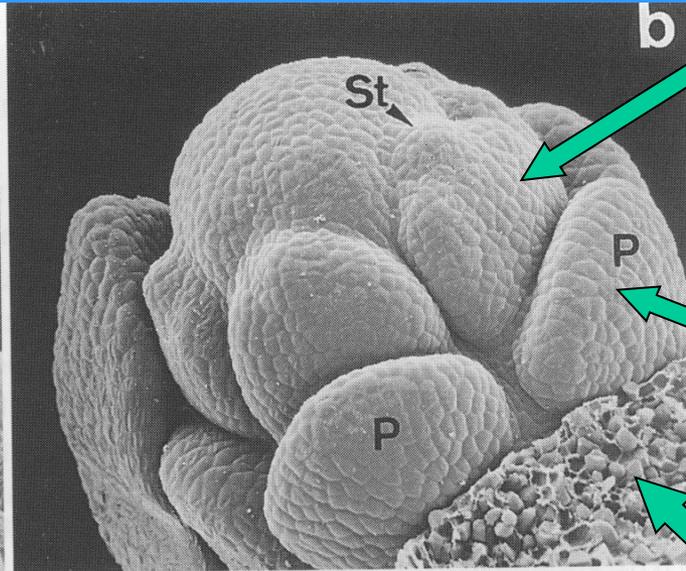
FLOR = ápice caulinar com folhas modificadas e esporângios organizados em internós muito curtos

ápice floral
meristemático



a

primórdio
de estame

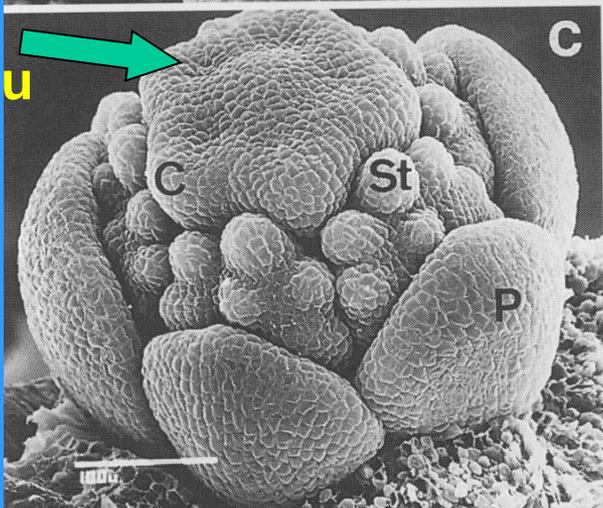


b

primórdio
de pétala

cicatriz
de sépala
que foi
removida

primórdio
do gineceu



c



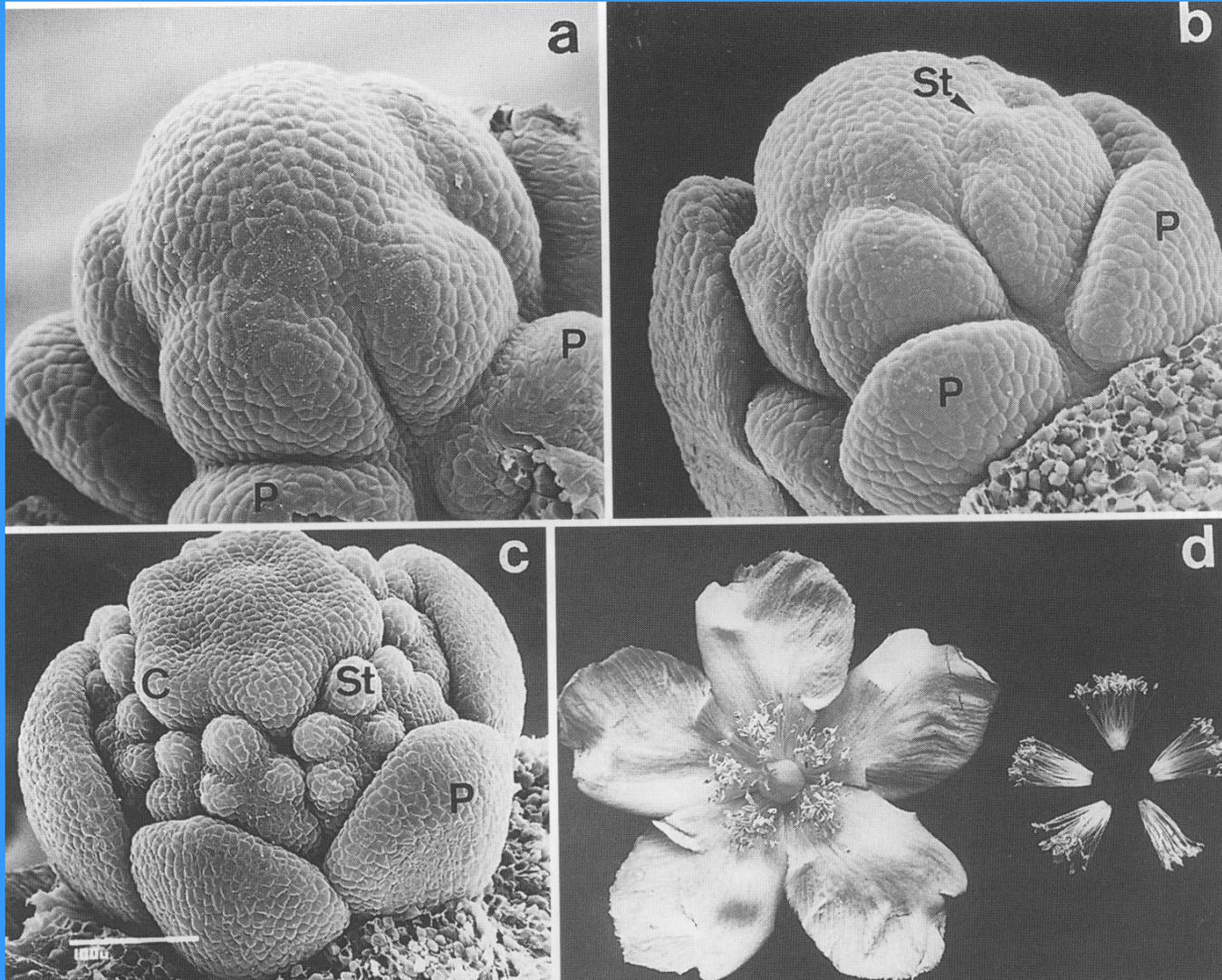
d

Hypericum hookerianum, Hypericaceae

Leins 2000

Em contexto evolutivo:

**FLOR = estróbilo heterosporangiado
com internós muito curtos**

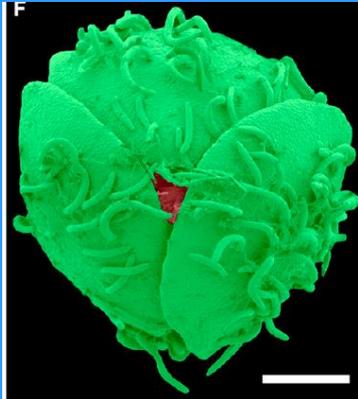


Hypericum hookerianum, Hypericaceae

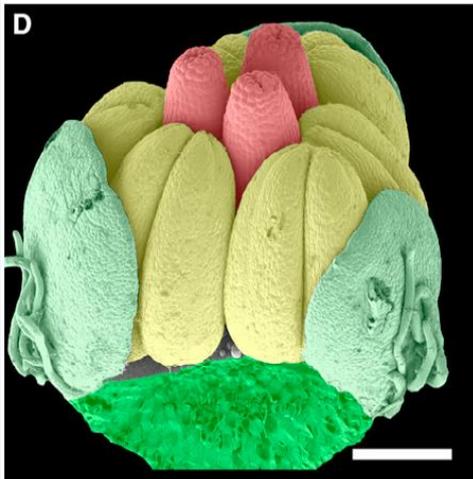
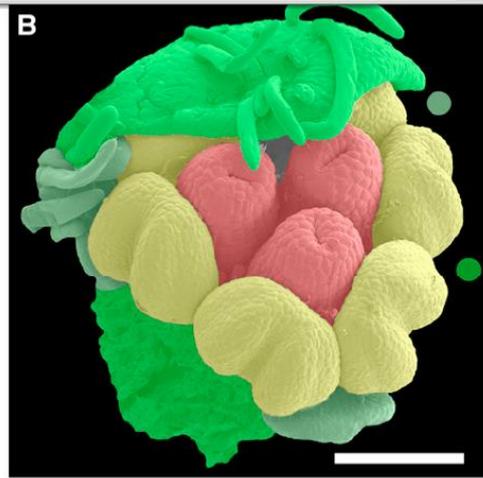
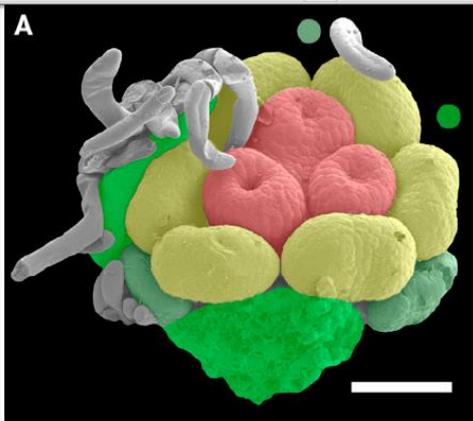
Leins 2000

Evodevótica Modelo ABC

Expressão gênica e o desenvolvimento dos primórdios das partes florais



Cabomba



Rudall et al. 2009

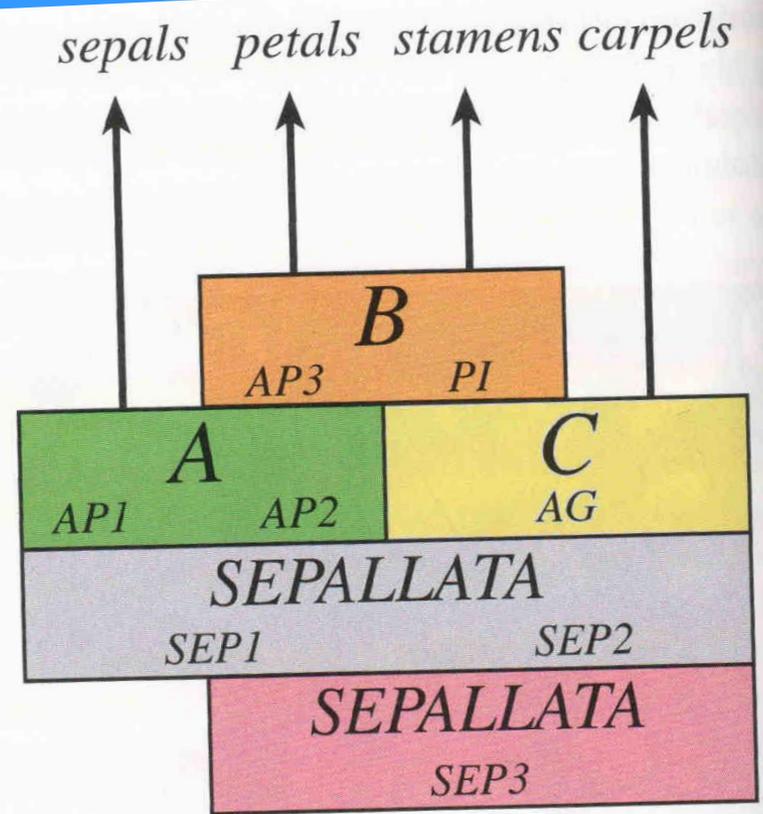
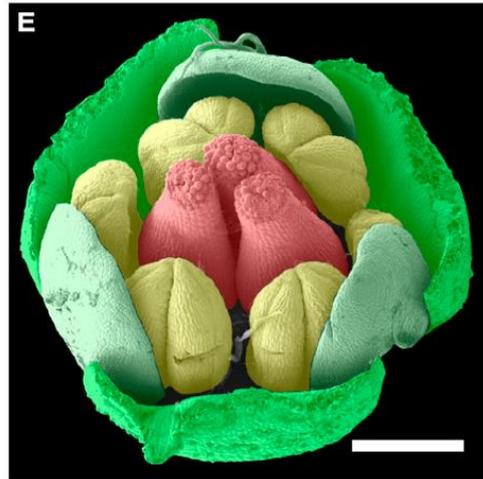


FIGURE 6.5 The “ABC” model of floral development. Within each gene class are specific genes (*AP1*, *AP2*, *AP3*, *AG*, *PI*, *SEP1*, *SEP2*, *SEP3*), identified in mutant forms in *Arabidopsis thaliana*. (Diagram after Jack, 2001.)

Simpson 2006

**PERIANTO:
cálice e corola**

Hypericum
Hypericaceae

**n de peças
por verticilo:**

Flores pentâmeras



Kielmeyera Guttiferae

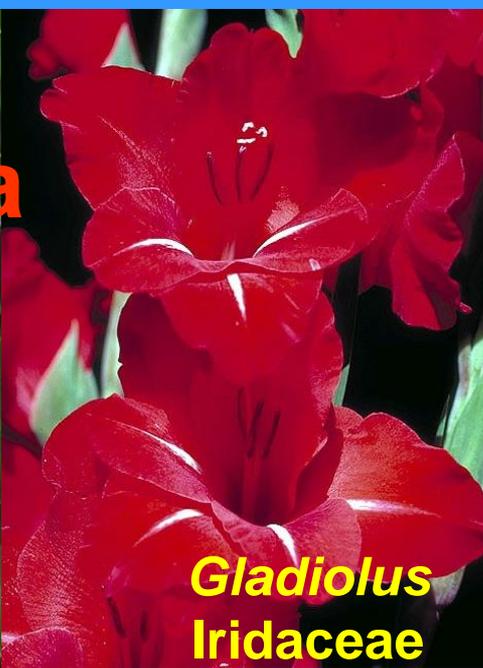


Camarea
Malpighiaceae

**PERIANTO:
cálice e corola**



Xylopia aromatica
Annonaceae



Gladiolus
Iridaceae



Liriodendron tulipifera
MAGNOLIACEAE

**n de peças
por verticilo:
Flores trímeras**



Trimezia IRIDACEAE

**PERIANTO:
cálice e corola**



Brugmansia
Solanaceae

Vaccinium
Ericaceae

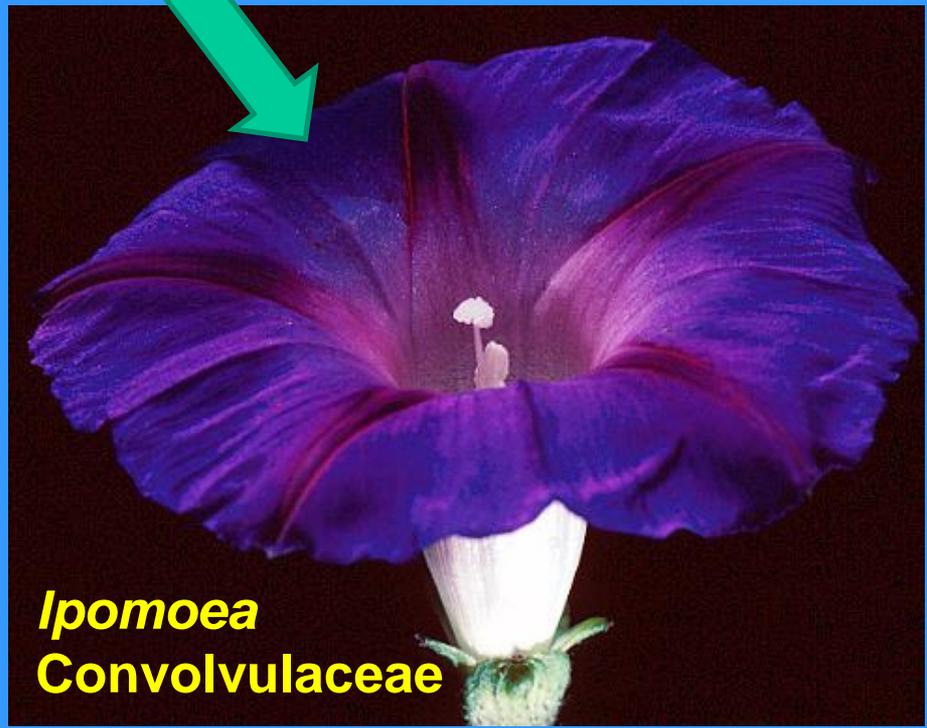


**UNIÃO
das peças
do perianto:
simpetalia**

**peças do
perianto
livres:
dialipetalia**



Papaver
Papaveraceae



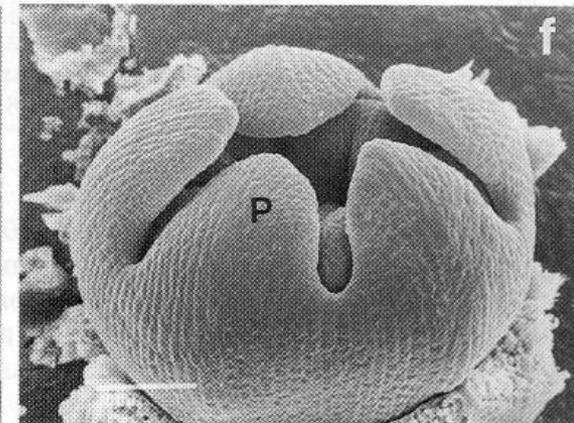
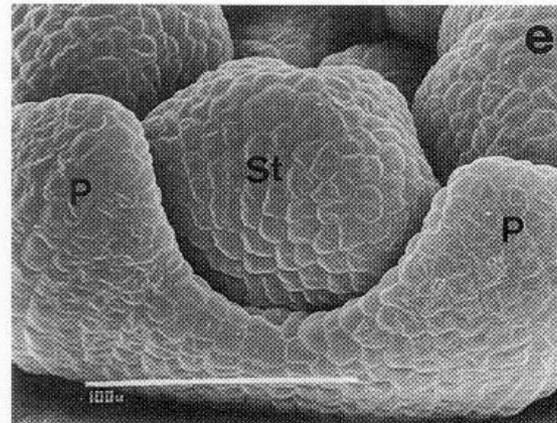
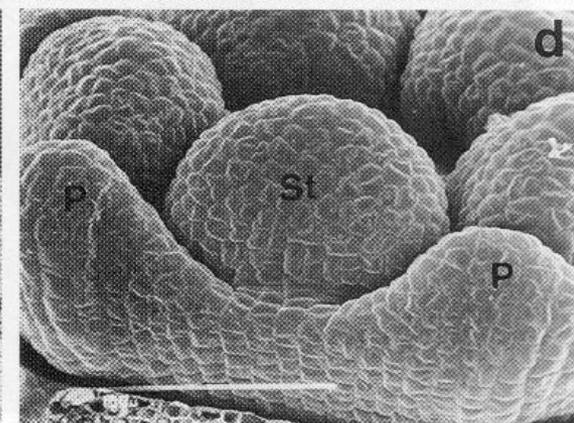
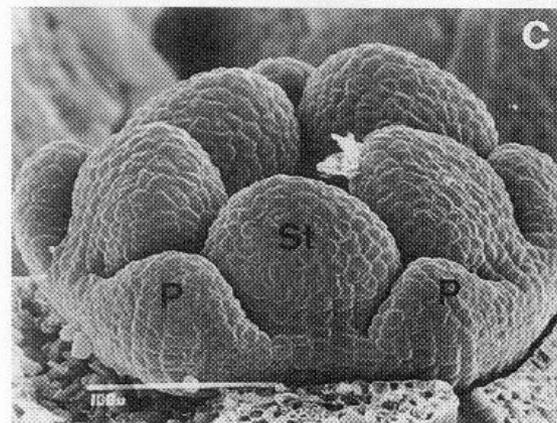
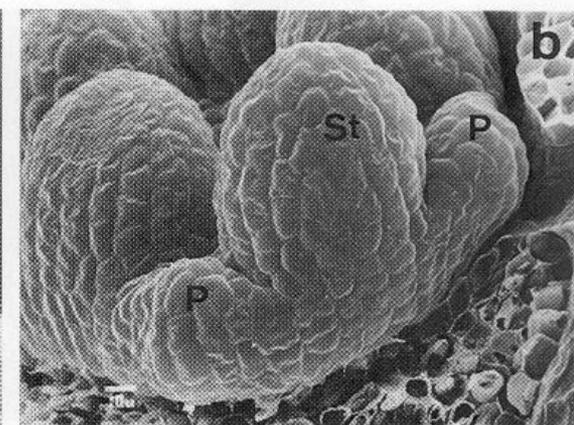
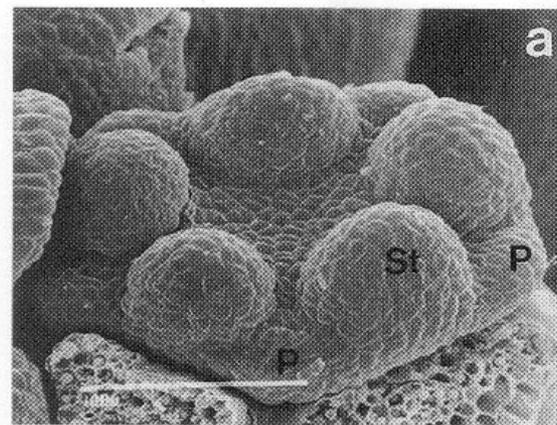
Ipomoea
Convolvulaceae

SIMPETALIA OU GAMOPETALIA

Ontogenia da
corola simpétala:



Anchusa officinallis,
Boraginaceae



Leins 2000

Lavoisiera
Melastomataceae

SIMETRIA do perianto
ACTINOMORFA ou Radial



Papaver, Papaveraceae





Collaea
Leguminosae

Aristolochia
Aristolochiaceae



Salvia
Labiatae

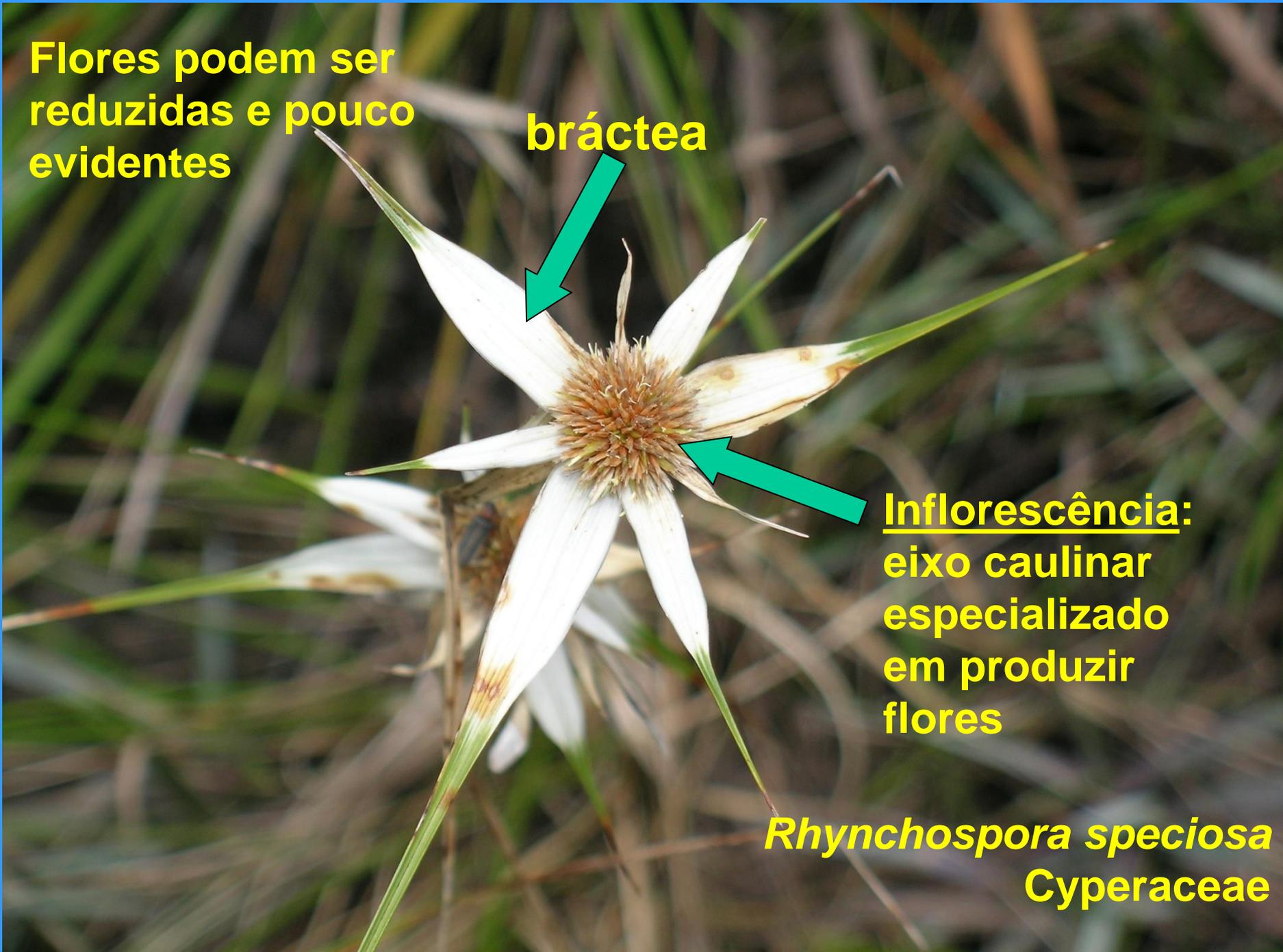
SIMETRIA ZIGOMORFA
(bilateral)

Flores podem ser
reduzidas e pouco
evidentes

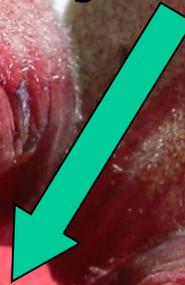
bráctea

Inflorescência:
eixo caulinar
especializado
em produzir
flores

Rhynchospora speciosa
Cyperaceae



ANDROCEU
Conjunto de estames



Hypericum, Hypericaceae
Estames numerosos

ANDROCEU



ANTERA

FILETE

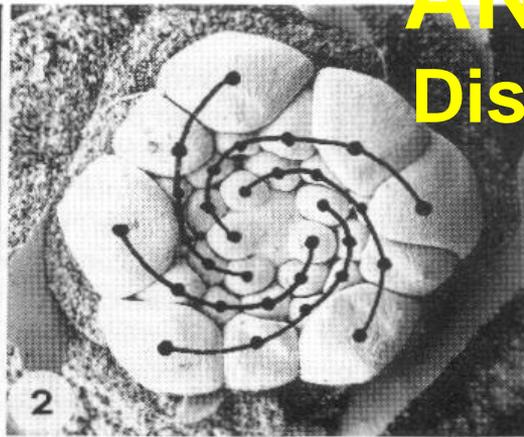
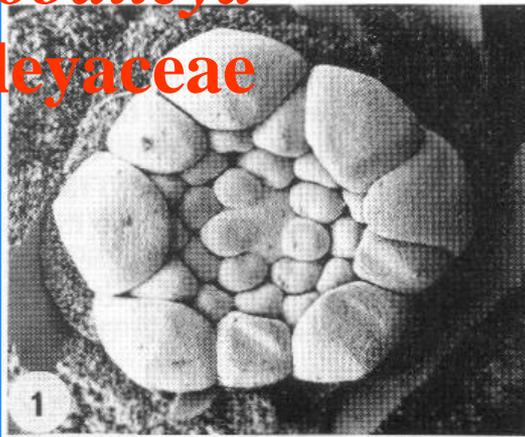
Lilium
Liliaceae

1 estame: *Qualea*
Vochysiaceae



Austrobaileya

Austrobaileyaceae

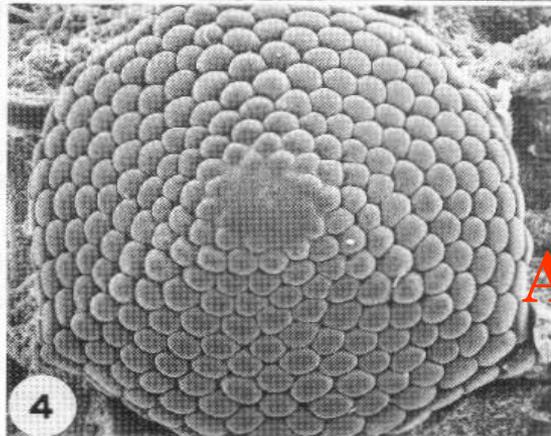
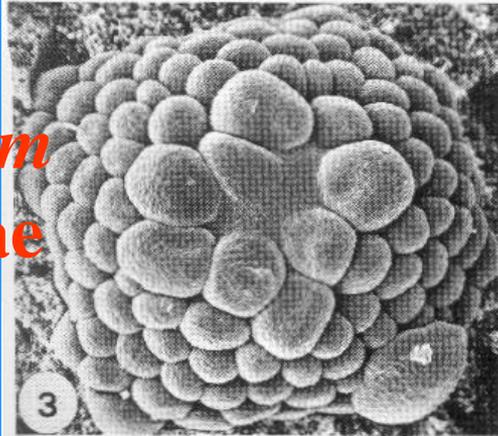


ANDROCEU

Disposição dos estames

estames
espiralados

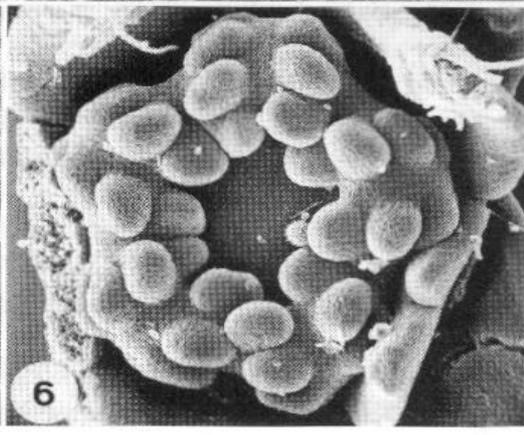
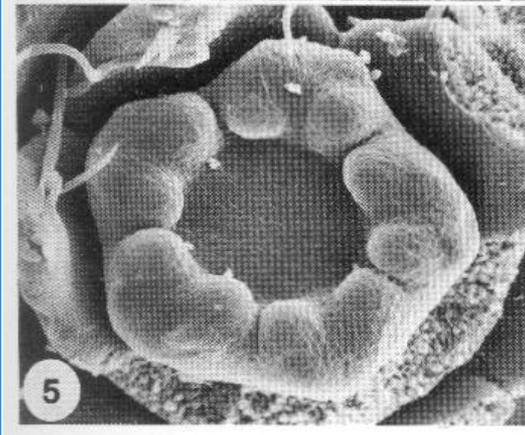
Annona
Annonaceae



Exospermum
Winteraceae

Kitaibelia
Malvaceae

estames
verticilados
Maioria das
angiospermas



Endress 1994

ANDROCEU

Transferência da
função atrativa
visual do perianto
para o androceu.

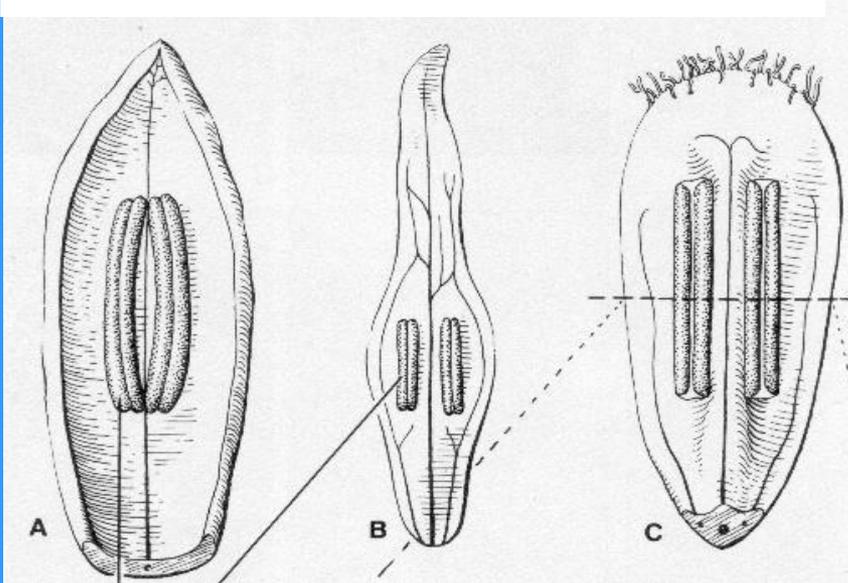


Mimosa
Leguminosae

Estames como folhas modificadas: microsporofilos

Magnolia sp
Magnoliaceae
Magnoliida

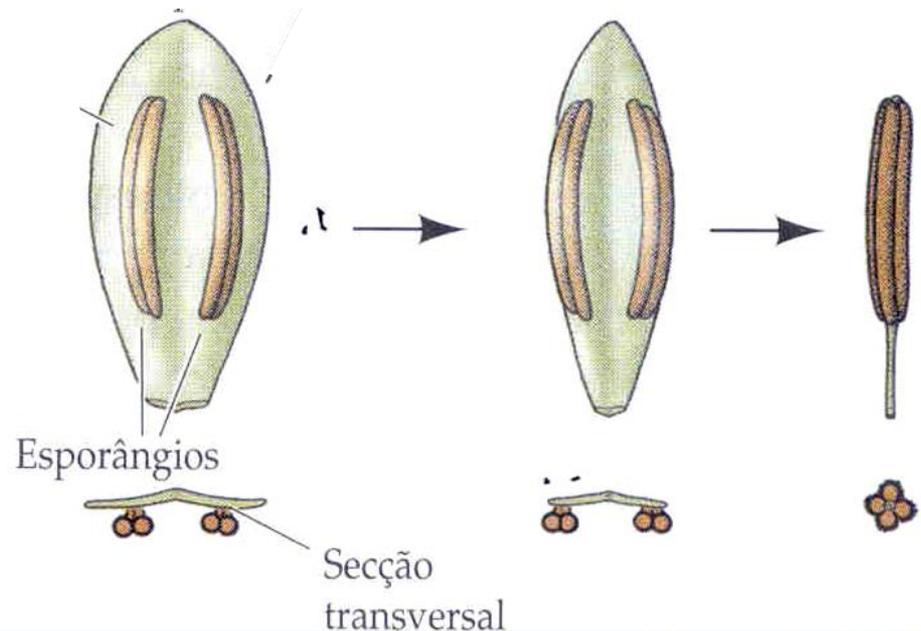
4 exemplos de plantas viventes com
estames laminares.



Austrobaileya *Himantandra* *Degeneria*

Gifford & Foster 1988

Hipótese da redução da área laminar
e mudança da posição dos microsporângios



Mauseth 1995

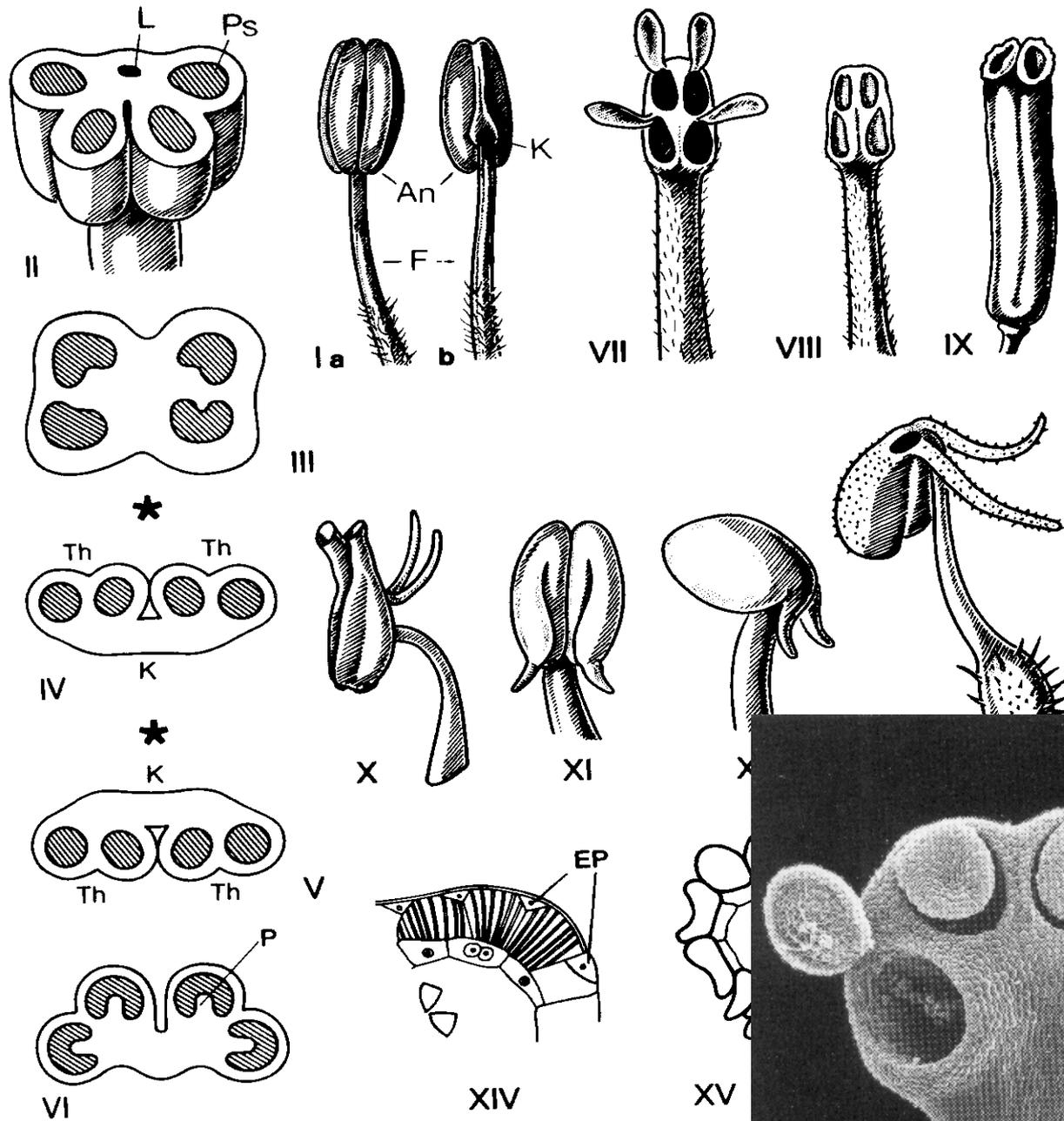


ANTERA:

2 TECAS

Cada teca com
2 microsporângios

3 tipos de abertura
das tecas,
liberando o pólen

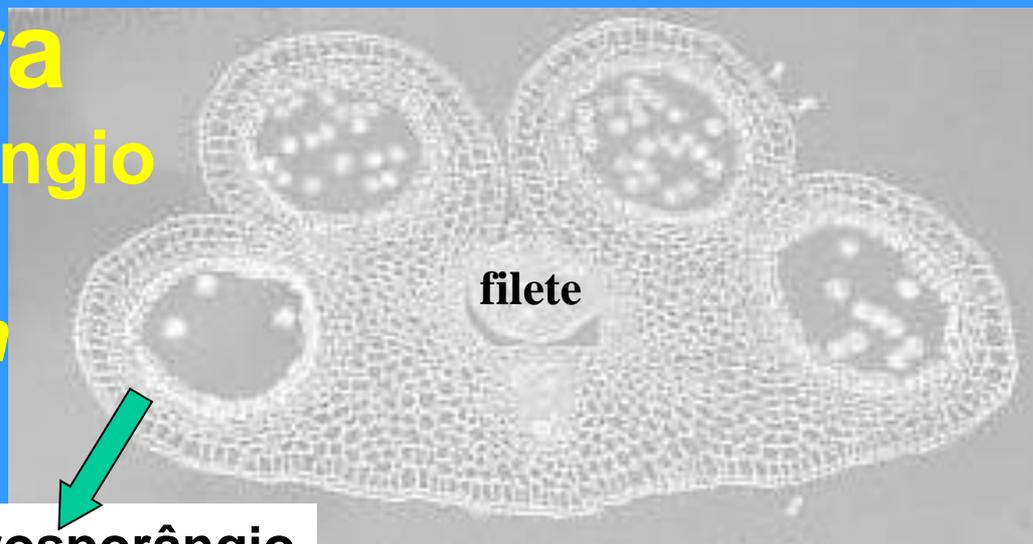


Cinnamomum



Antera
É um sinângio

Lilium

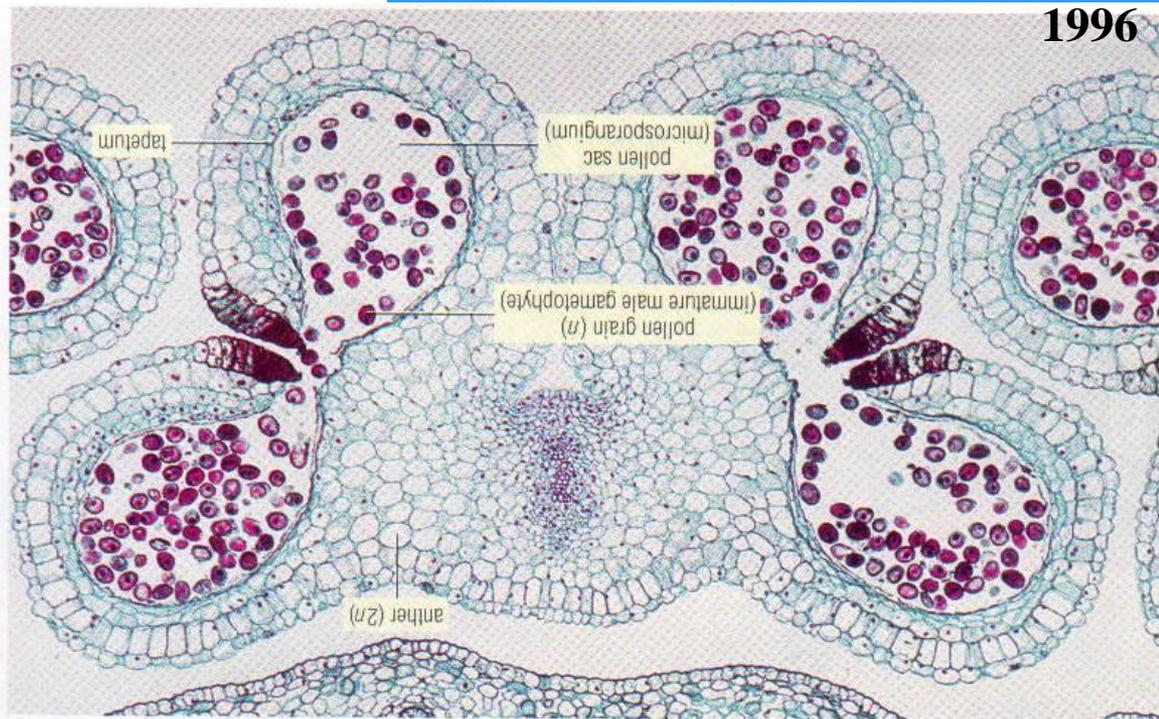
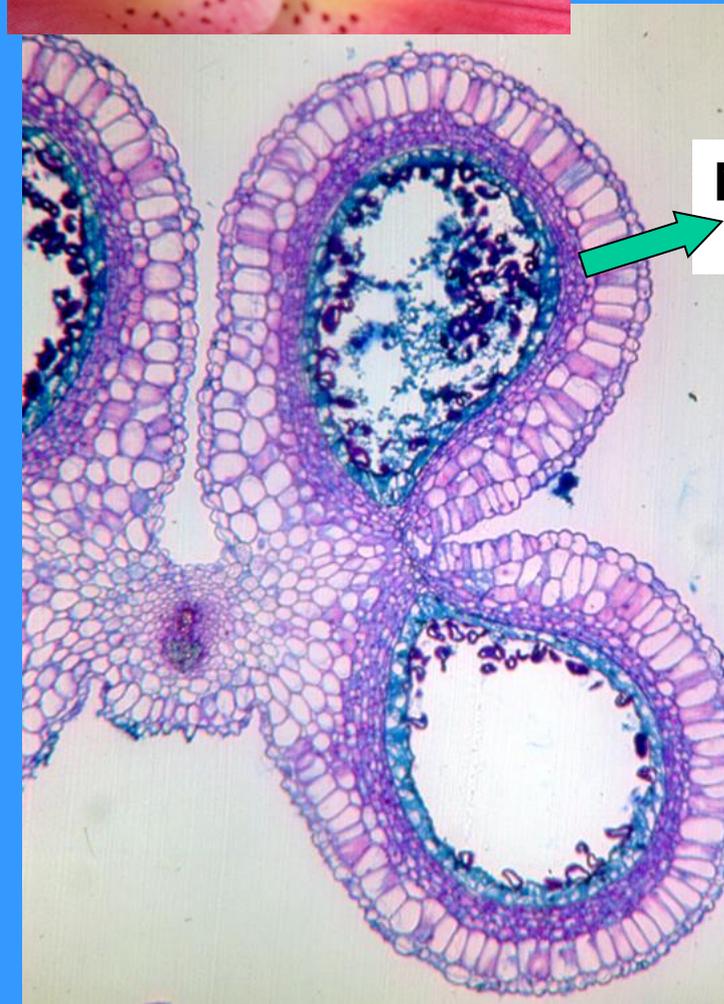


filete

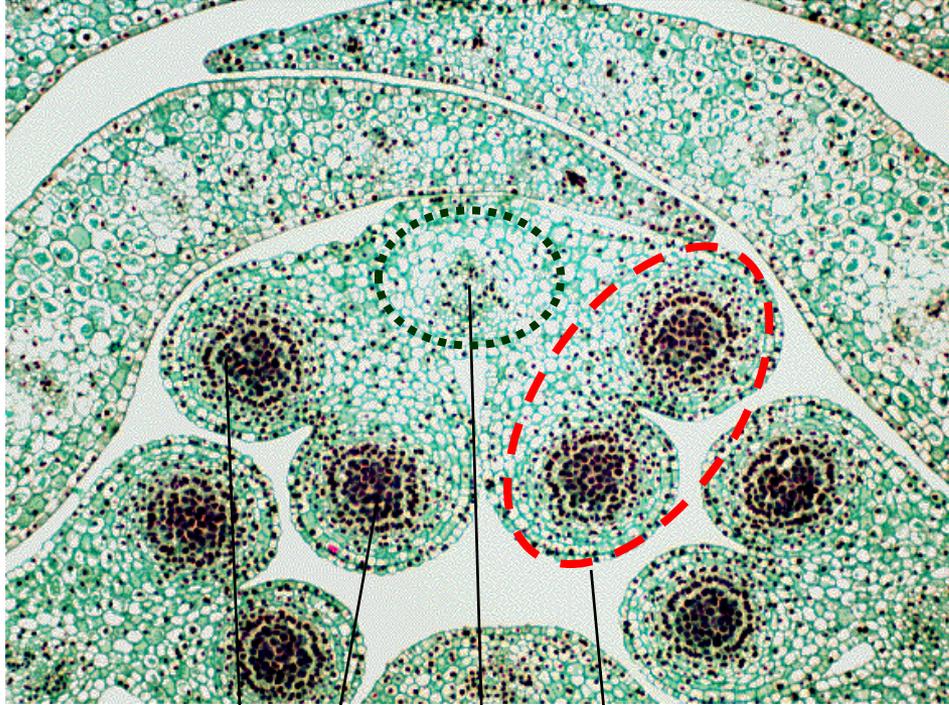
Microsporângio
ou saco polínico

Perry & Morton

1996



Antera: um sinângio



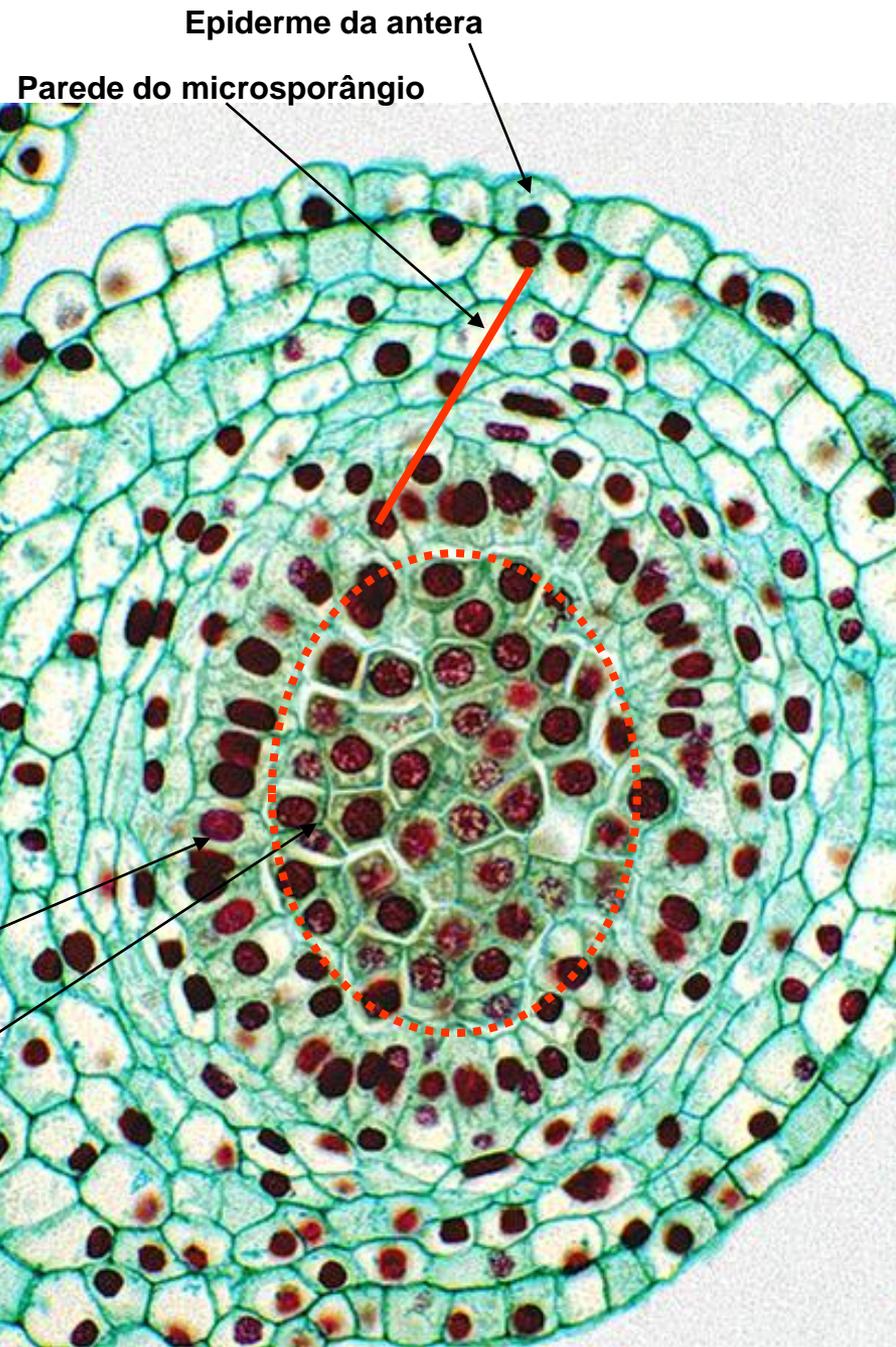
Microsporângio

Conectivo

Teca

Tapete

Tecido esporogênico
(células mãe-de-micrósporos)



Epiderme da antera

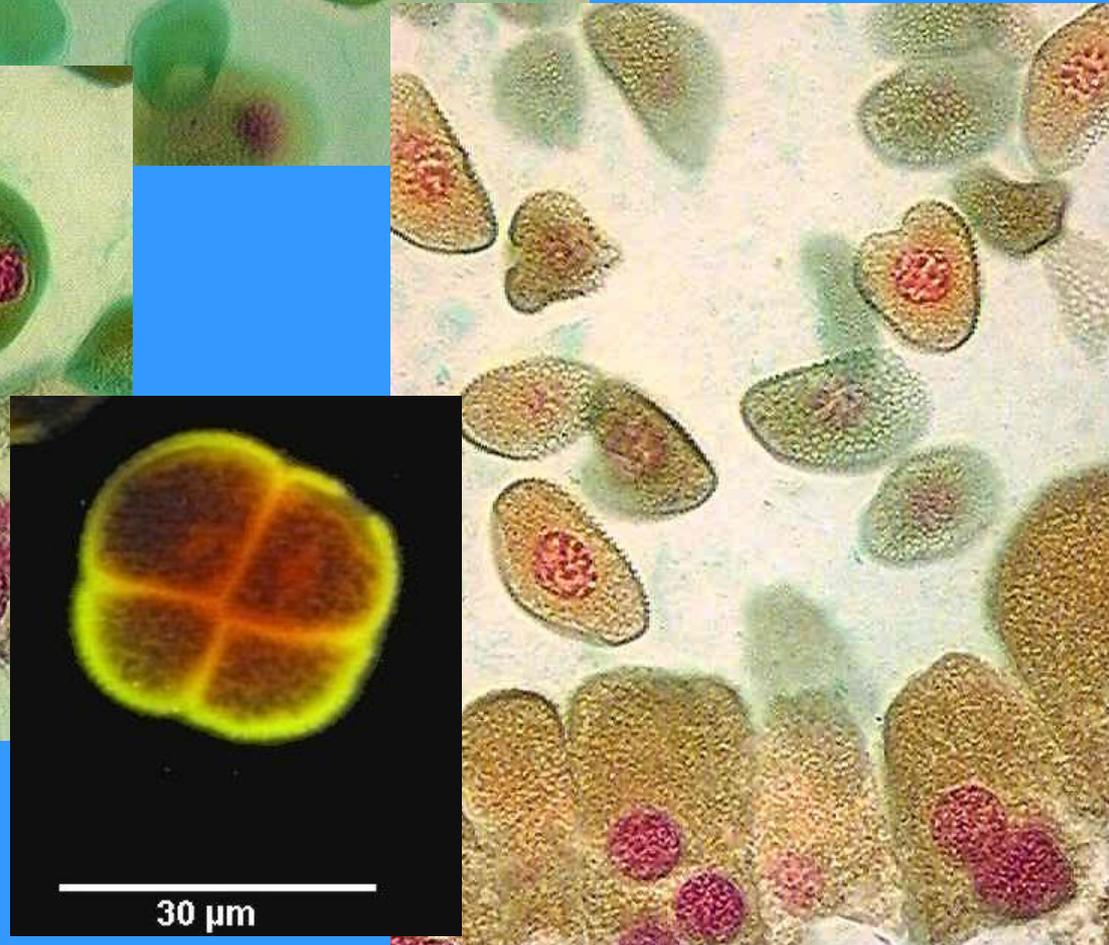
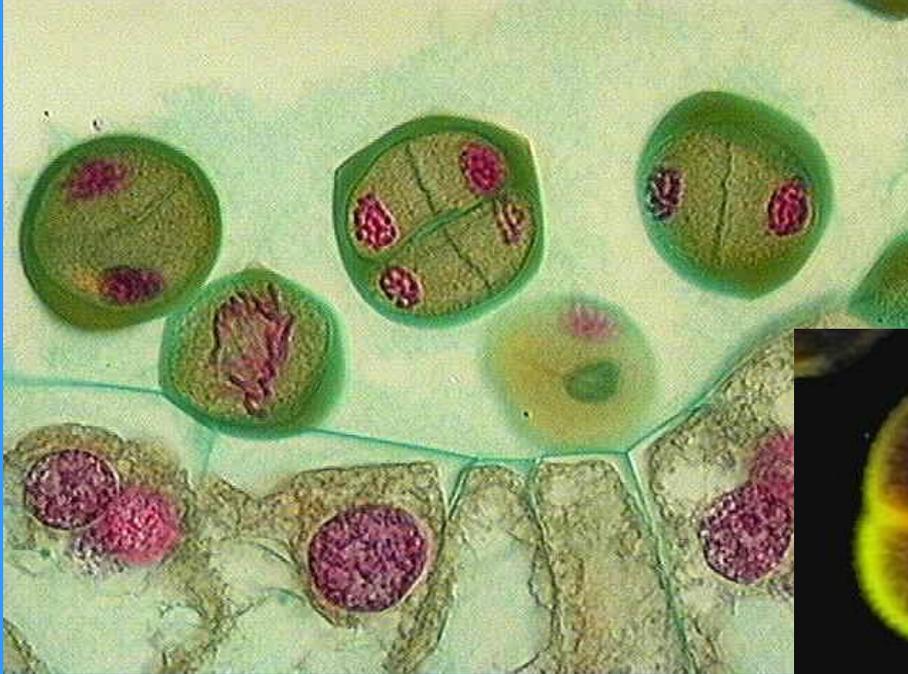
Parede do microsporângio

Lilium sp
Liliaceae
Monocotiledônea

Tétrades de
microsporos

Meiose - R!

Antera

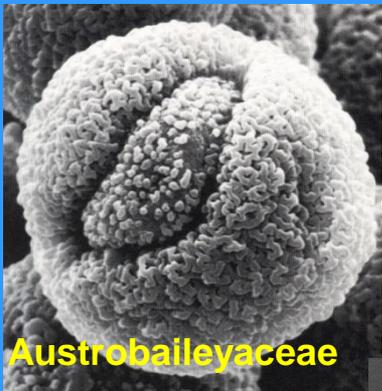


Lilium sp
Liliaceae

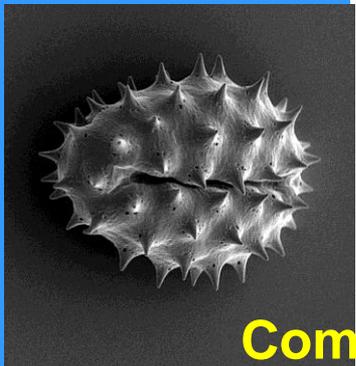
30 μ m

PÓLEN

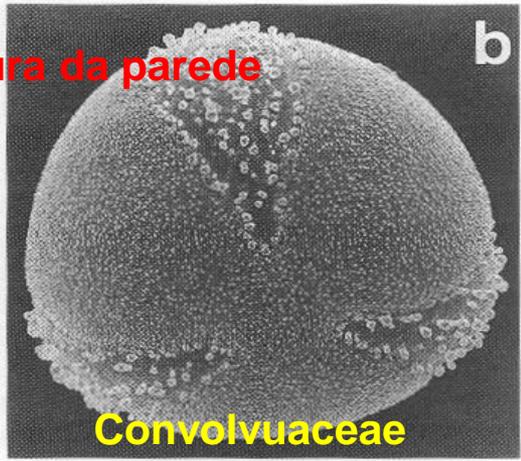
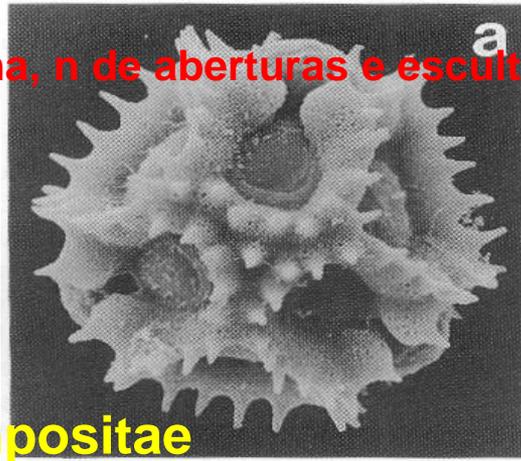
– variações na forma, n de aberturas e escultura da parede



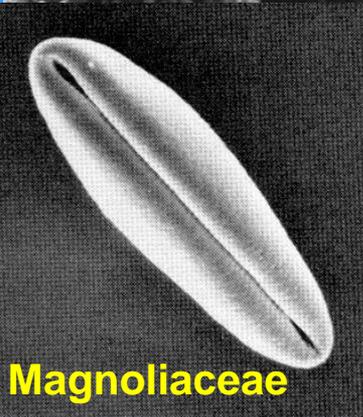
Austrobaileyaceae



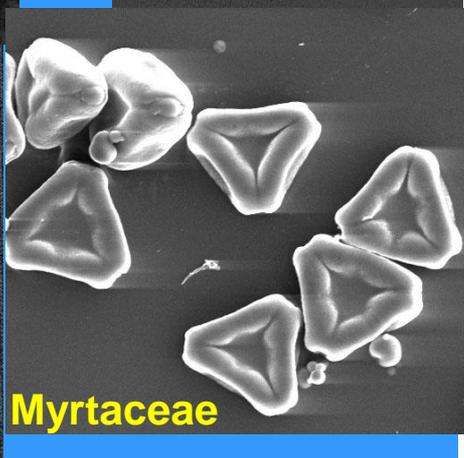
Compositae



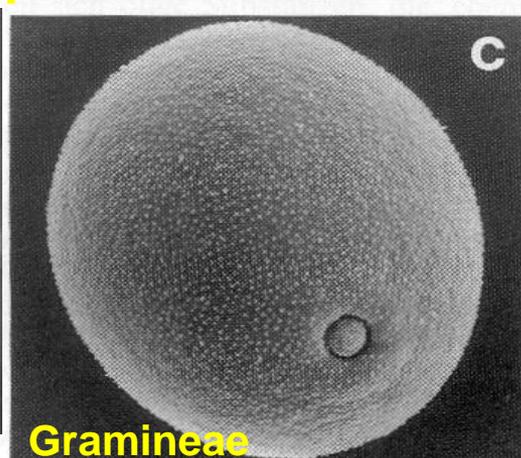
Convolvuaceae



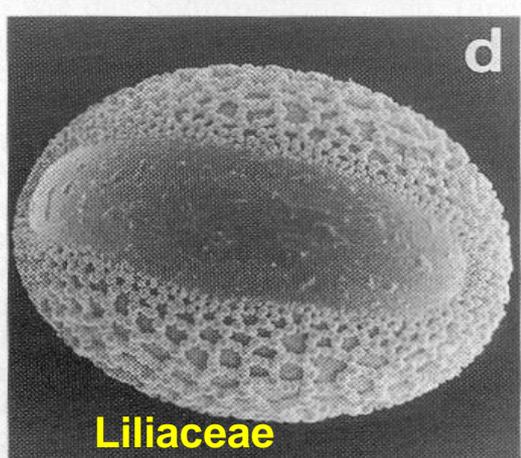
Magnoliaceae



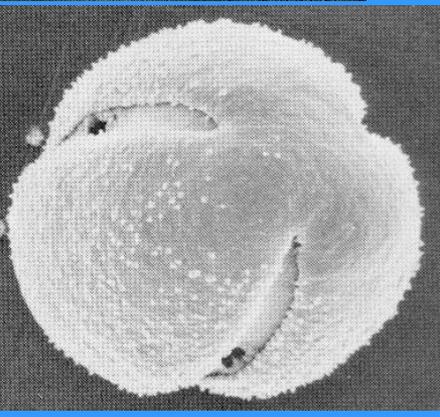
Myrtaceae



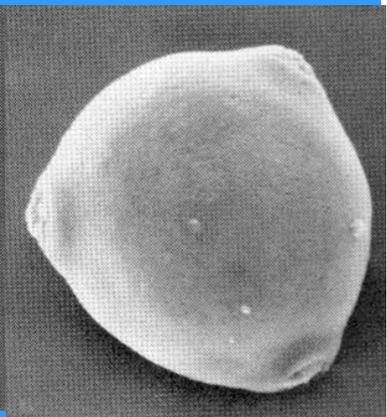
Gramineae



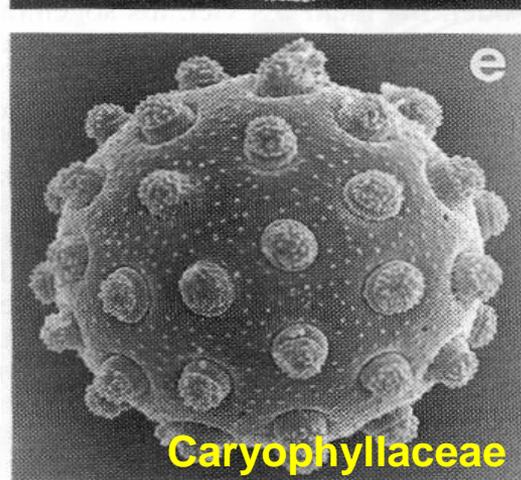
Liliaceae



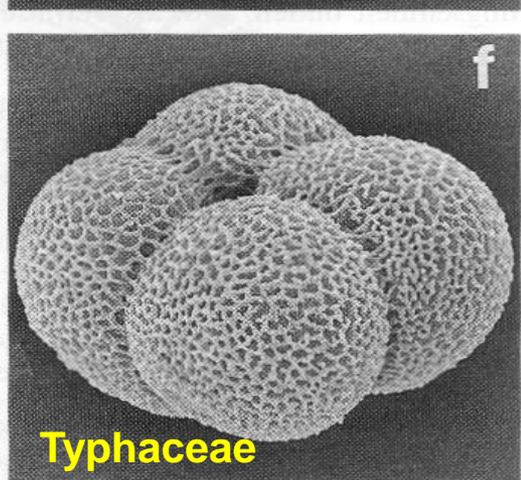
Goodeniaceae



Cucurbitaceae



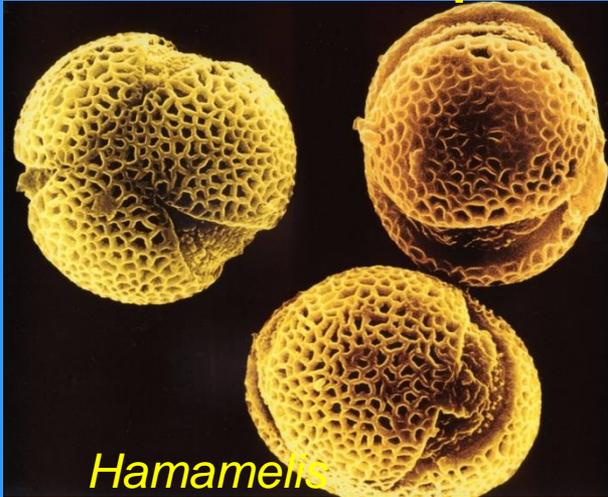
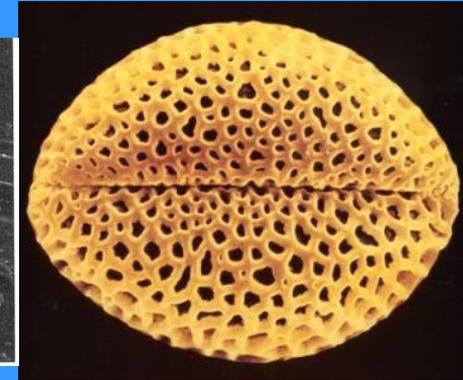
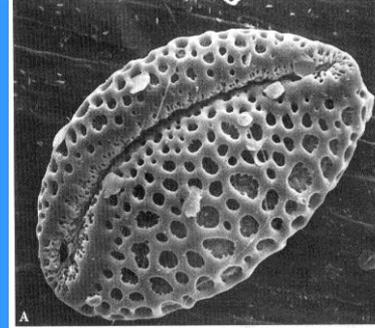
Caryophyllaceae



Typhaceae

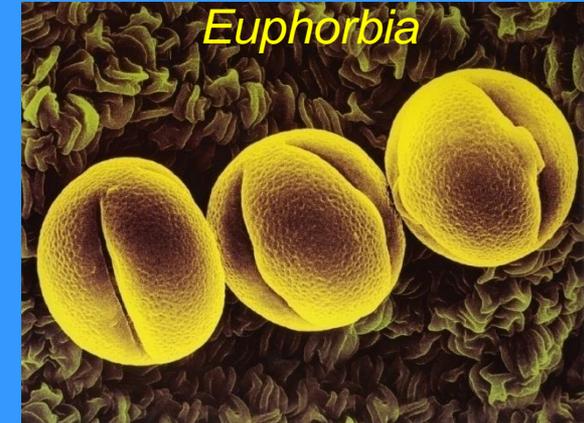
Diversidade de PÓLEN de angiospermas – alta informatividade para taxonomia e evolução

pólen monossulcado



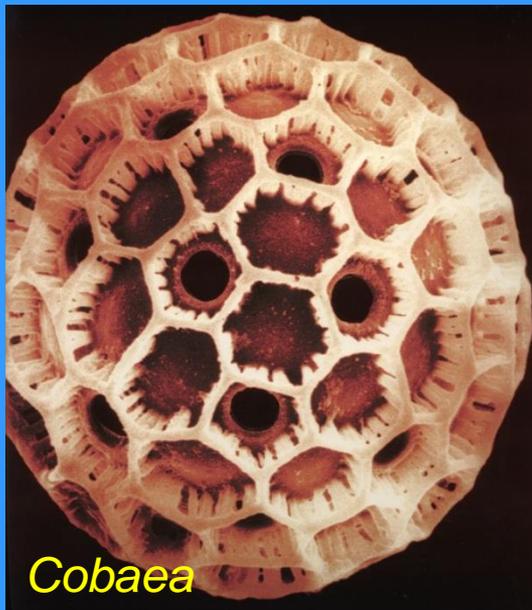
Hamamelis

pólen tricolpado



Euphorbia

pólen tricolporado



Cobaea

pólen porado

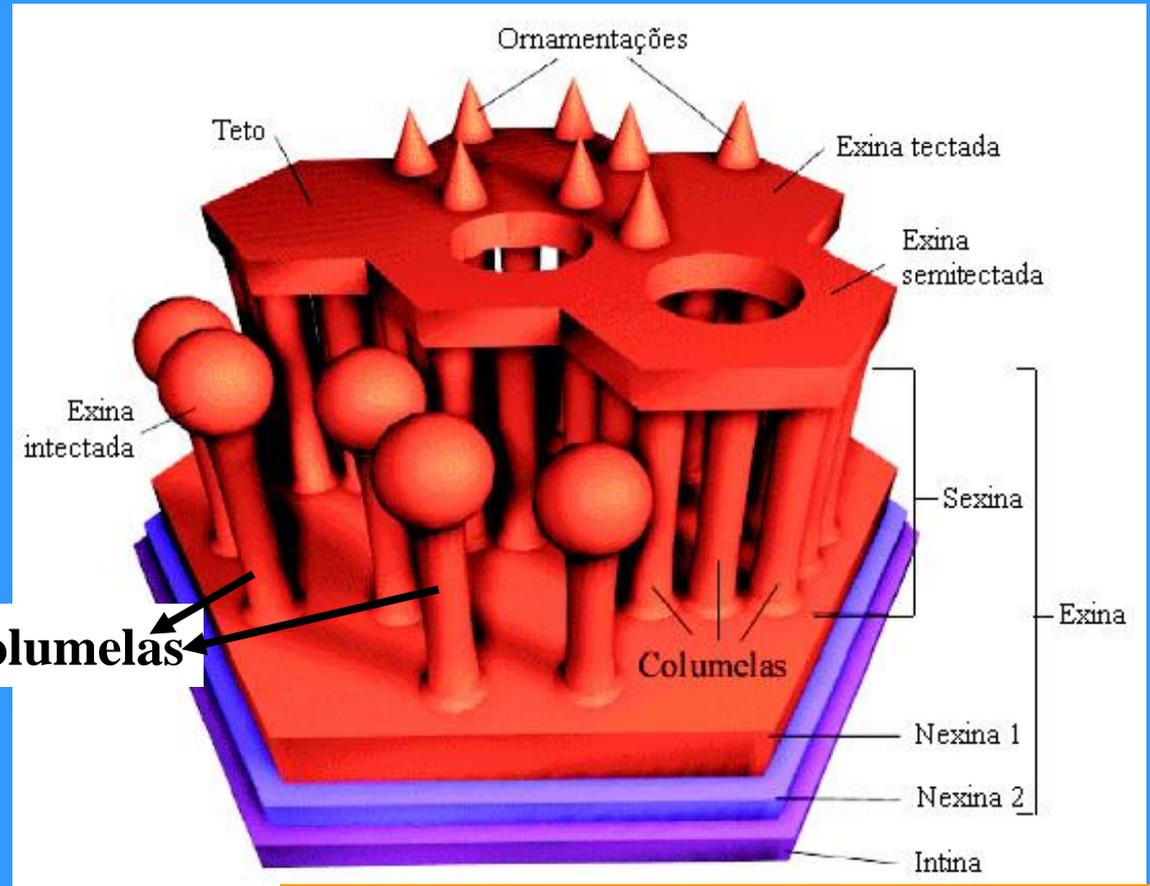
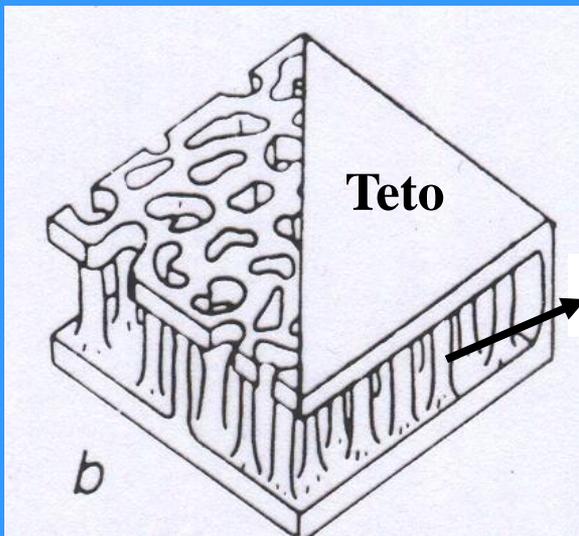


Silene



Aesculus

Parede do pólen

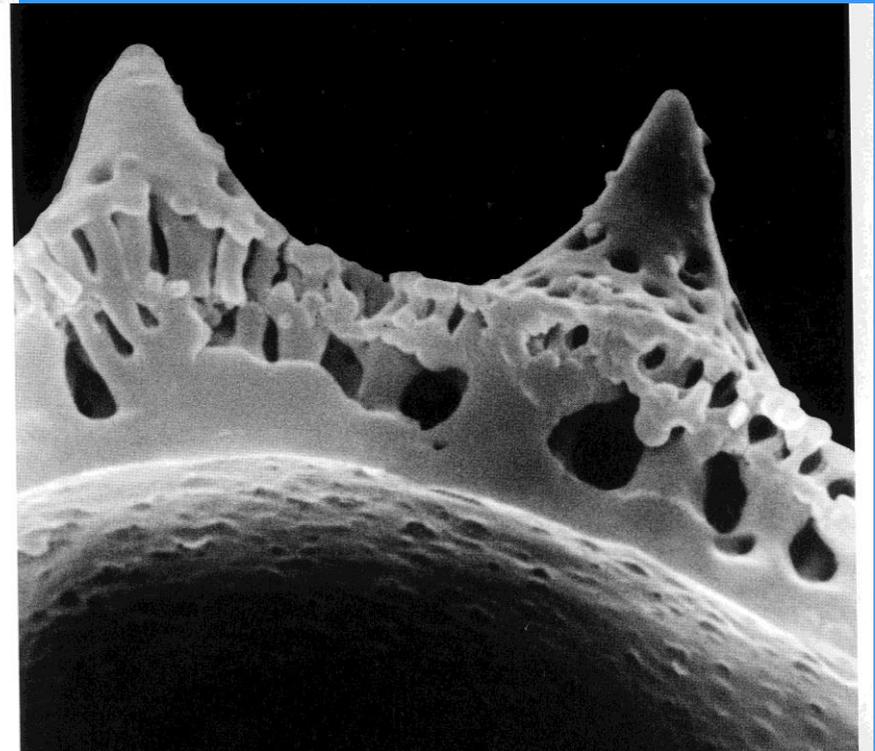
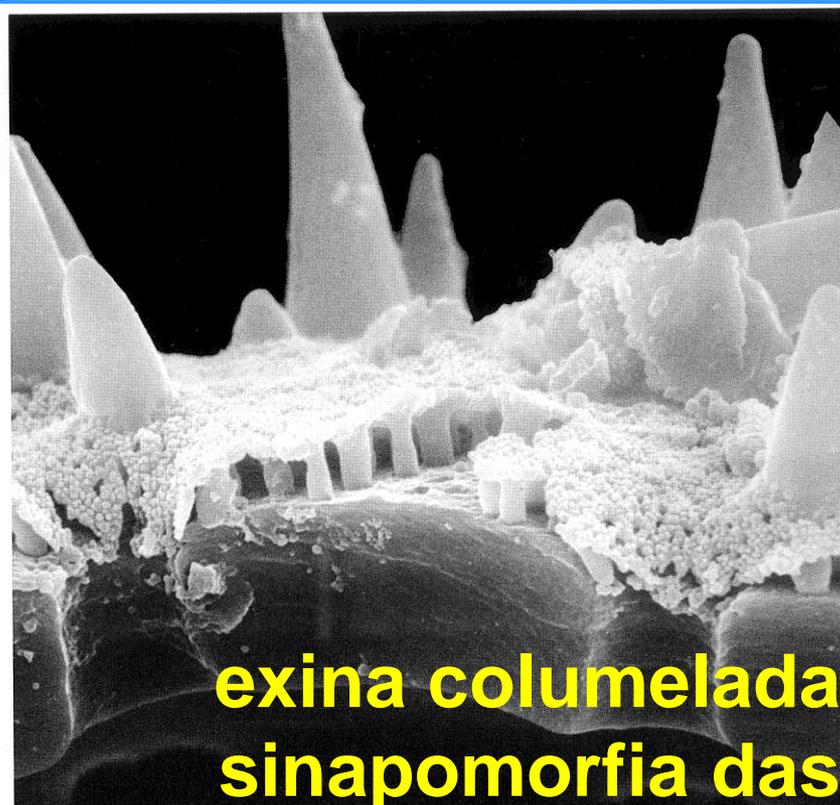
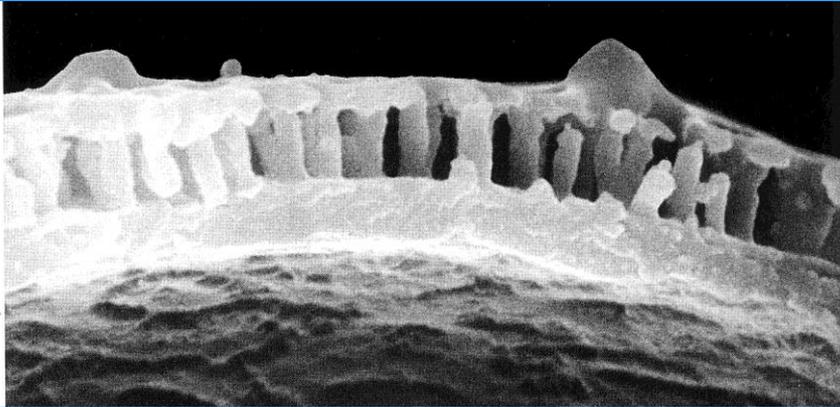


**Esporopolenina
(na parede externa)**

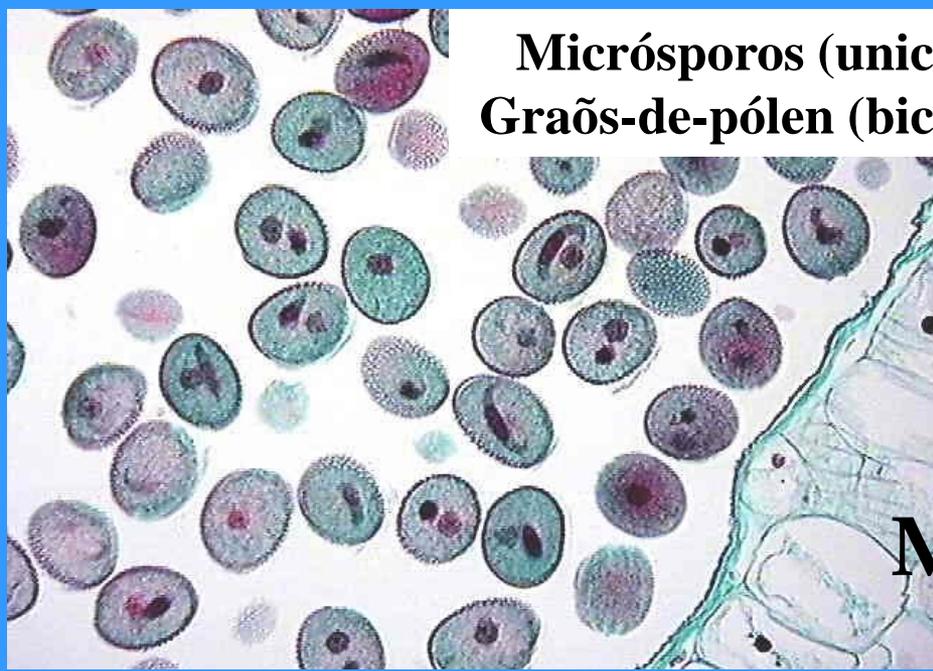


Columelas

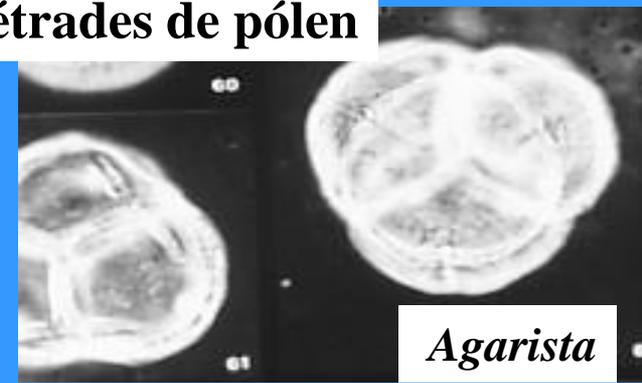
PÓLEN



Micrósporos (unicelulares)
Graões-de-pólen (bicelulares)

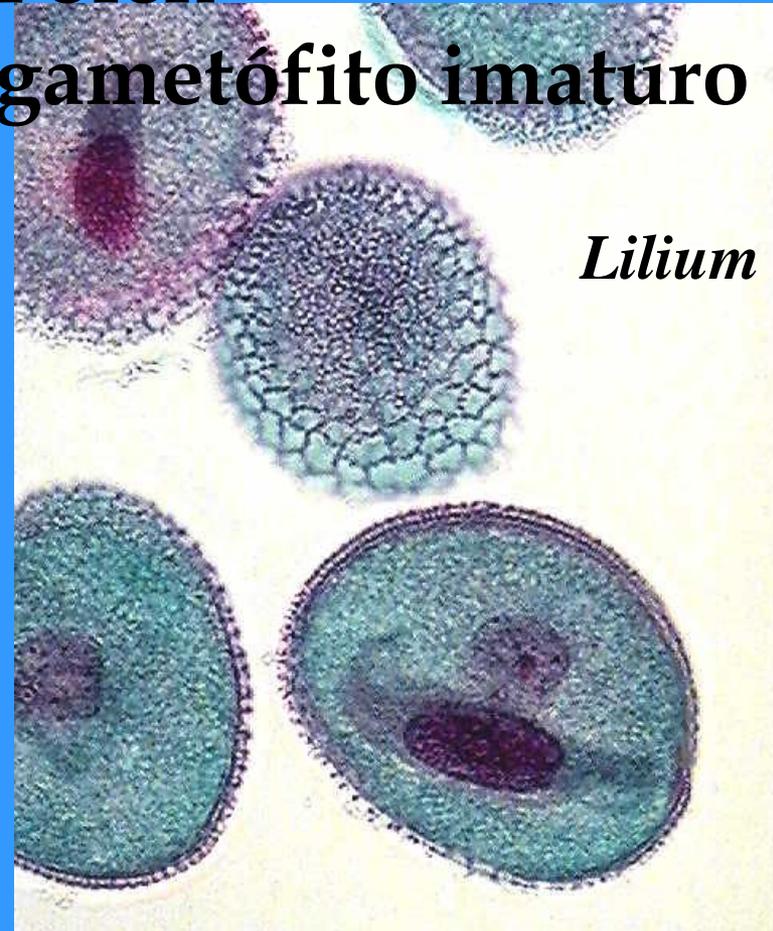
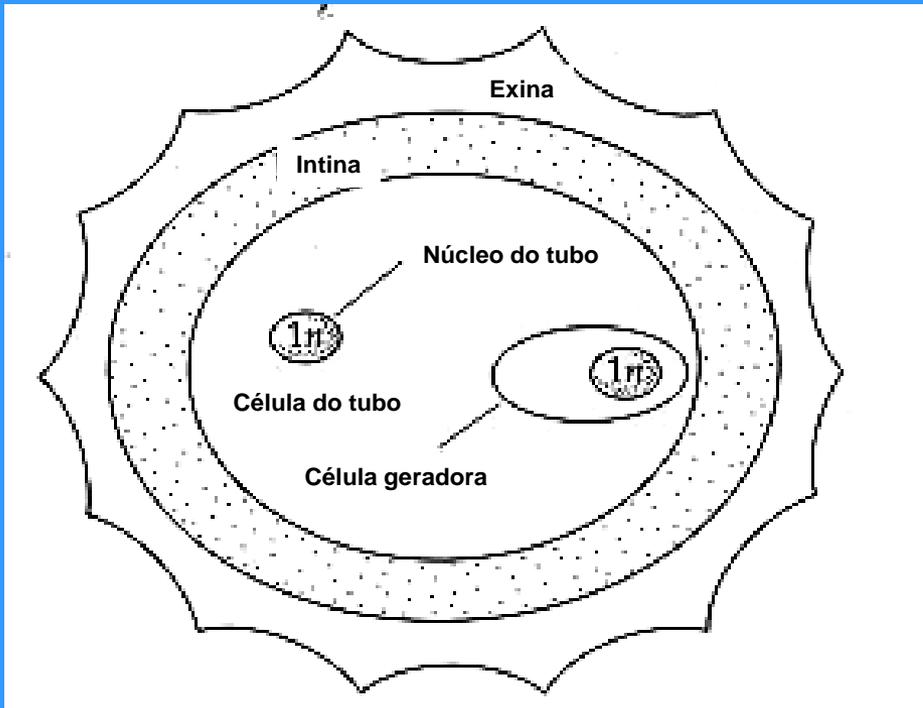


Tétrades de pólen



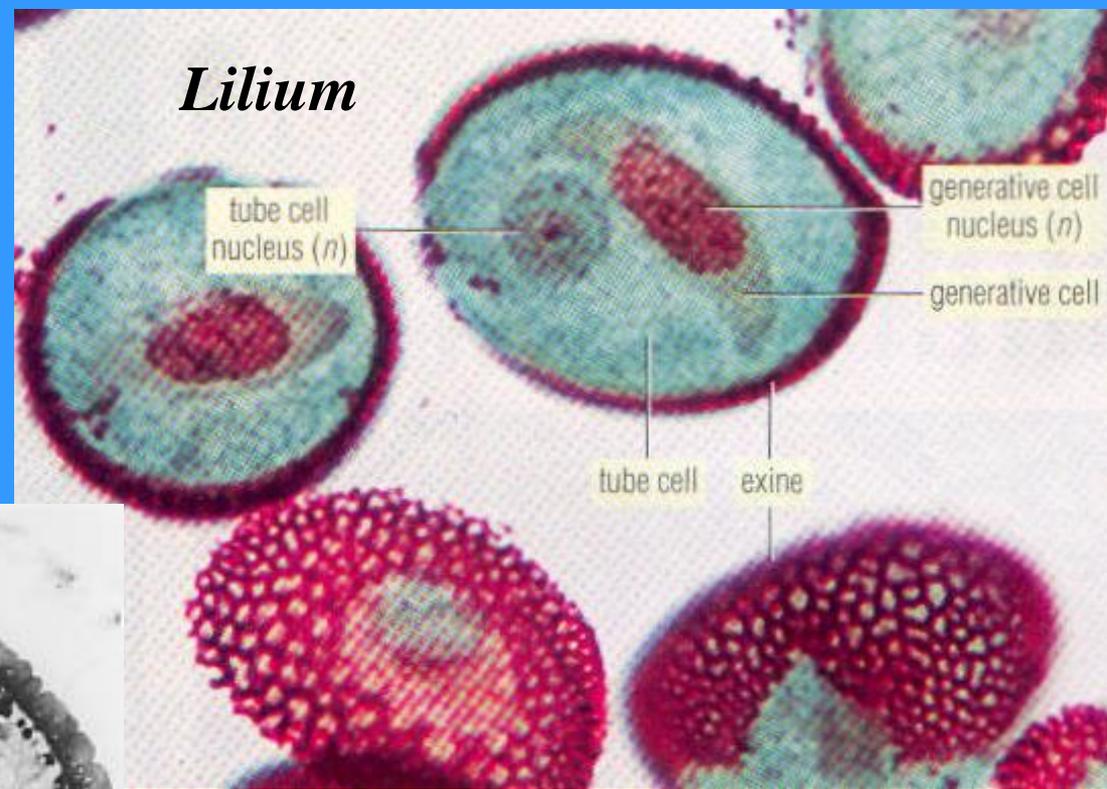
Agarista

**Pólen =
Microgametófito imaturo**

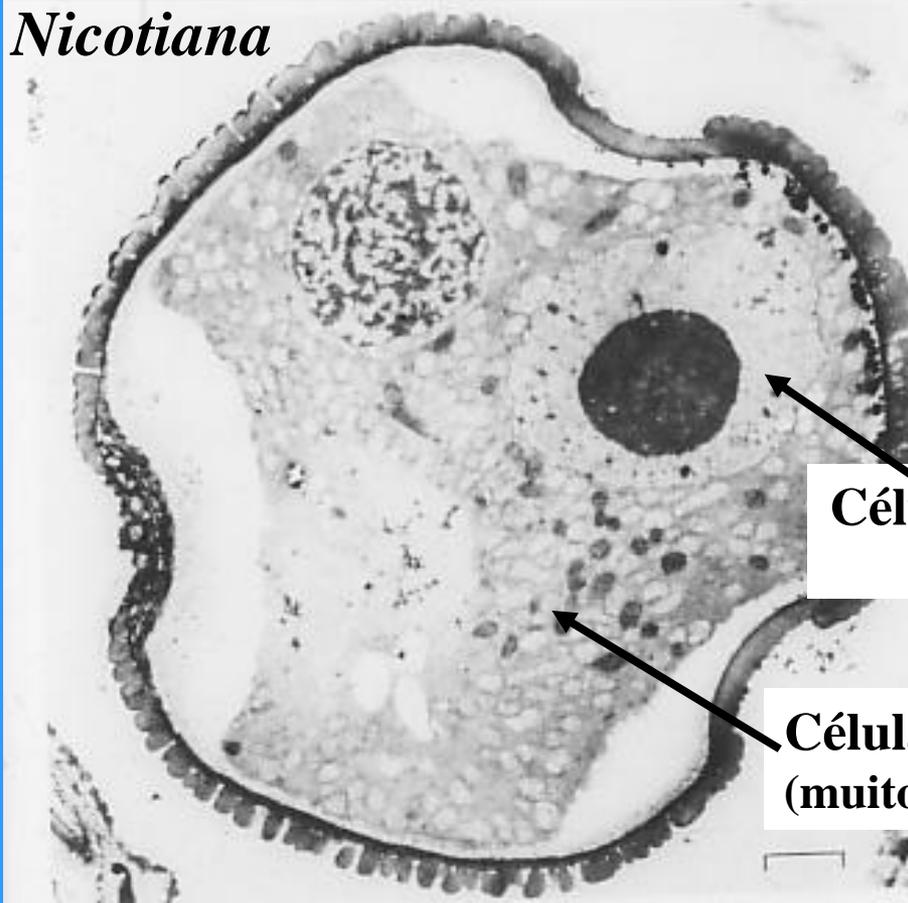


Lilium

**Pólen =
Microgametófito
endospórico imaturo**



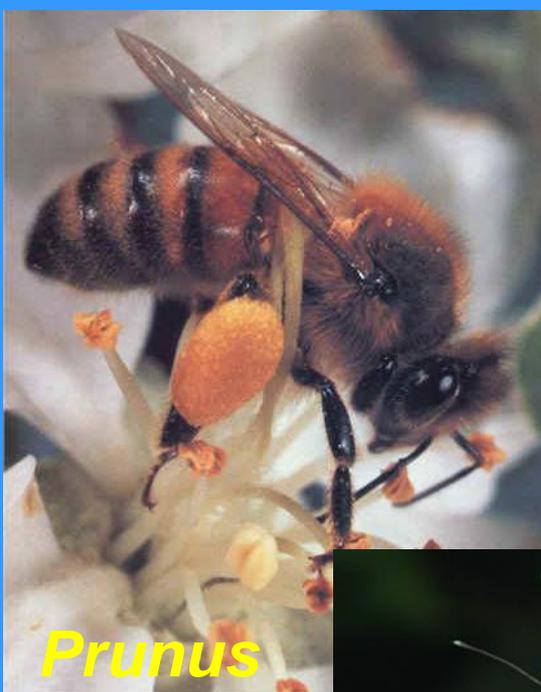
Nicotiana



**Célula geradora
(núcleo denso)**

**Célula do tubo
(muito vacuolizada)**

POLINIZAÇÃO



Prunus

entomofilia



anemofilia

Poaceae



ornitofilia

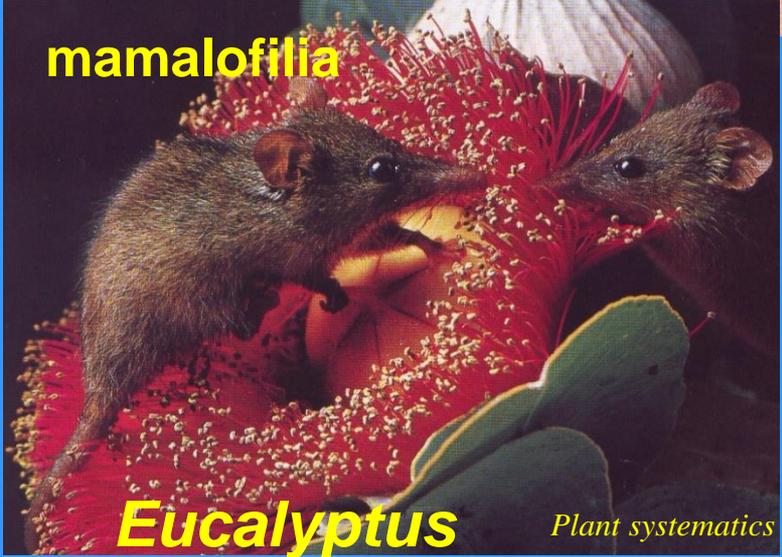


Conchocarpus



quiropterofilia

Passiflora



mamalofilia

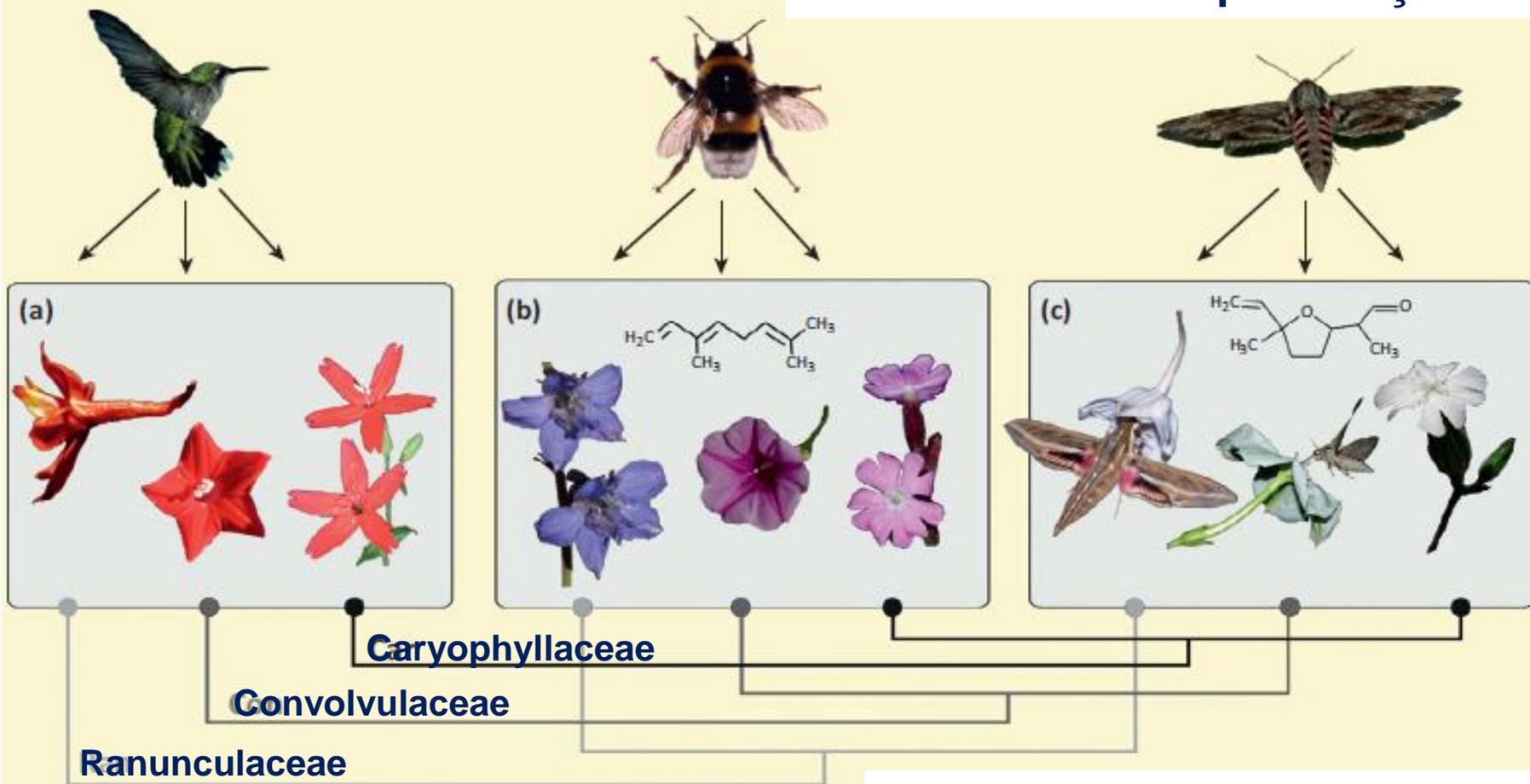
Eucalyptus

Síndromes florais relacionadas à biologia de polinização

Schiestl & Johnson 2013

Filogenias de 3 famílias mostrando evolução convergente de 3 síndromes de polinização

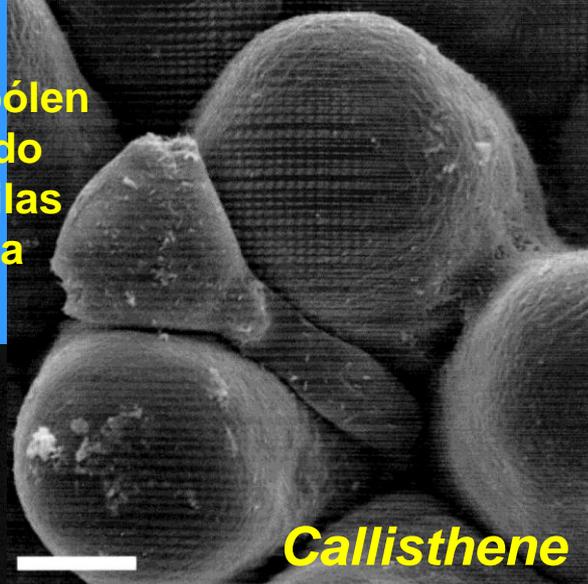
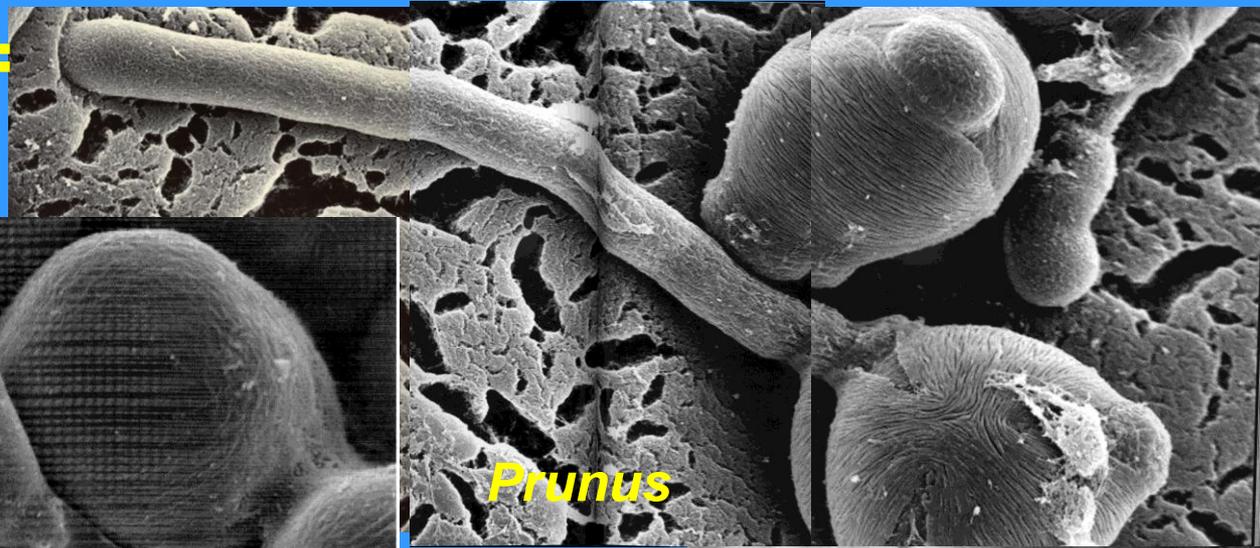
(A) Floral signal convergence: pollination syndromes



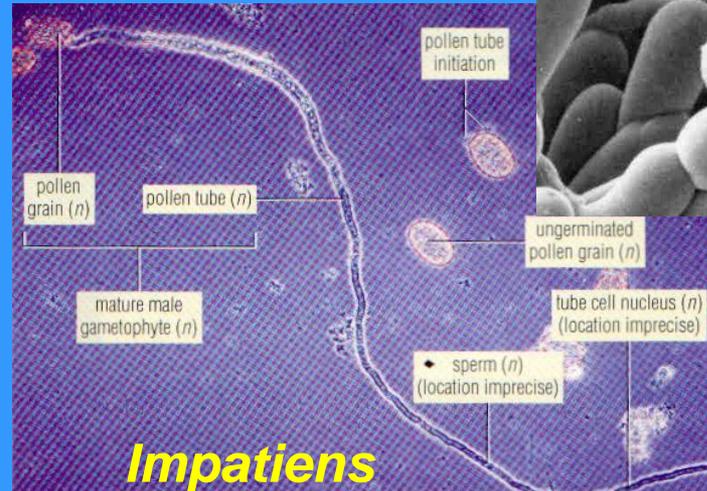
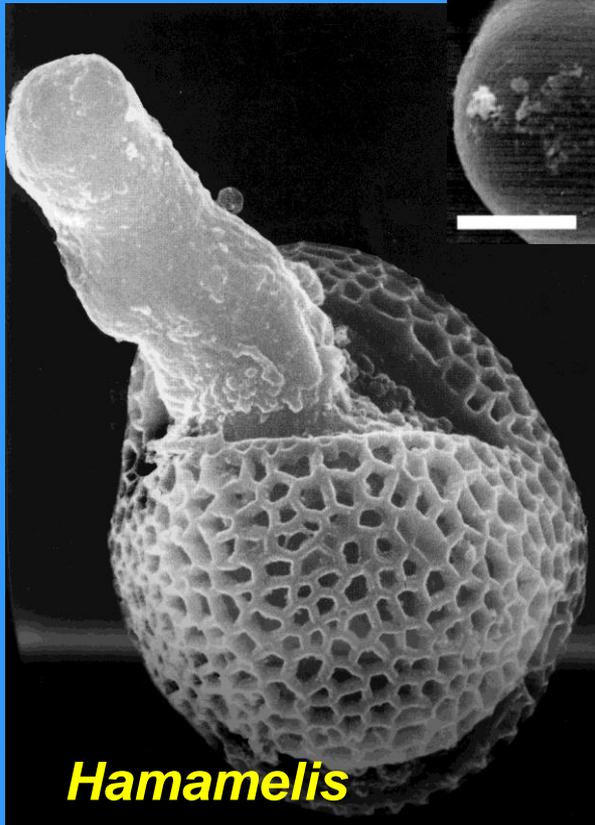
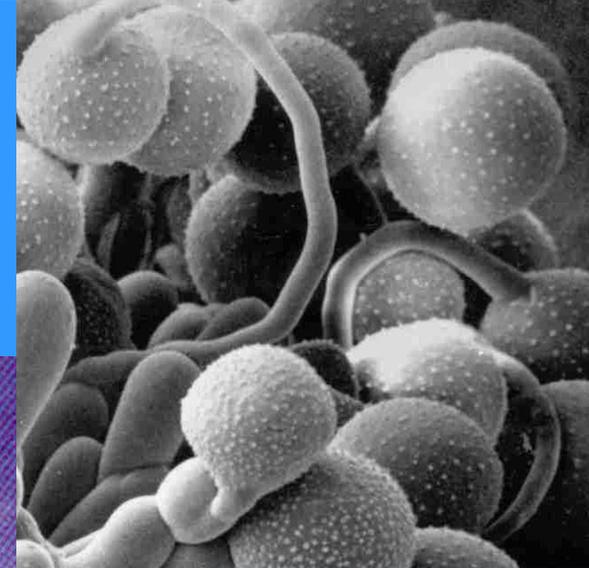
Obs: Resumo das síndromes disponibilizado no e-disciplinas

Tubo polínico = Microgametófito maduro

Grão-de-pólen
germinando
entre papilas
do estigma



Carmo-Oliveira & Morretes 2009



Perry & Morton 1996

Desenvolvimento rápido do tubo polínico

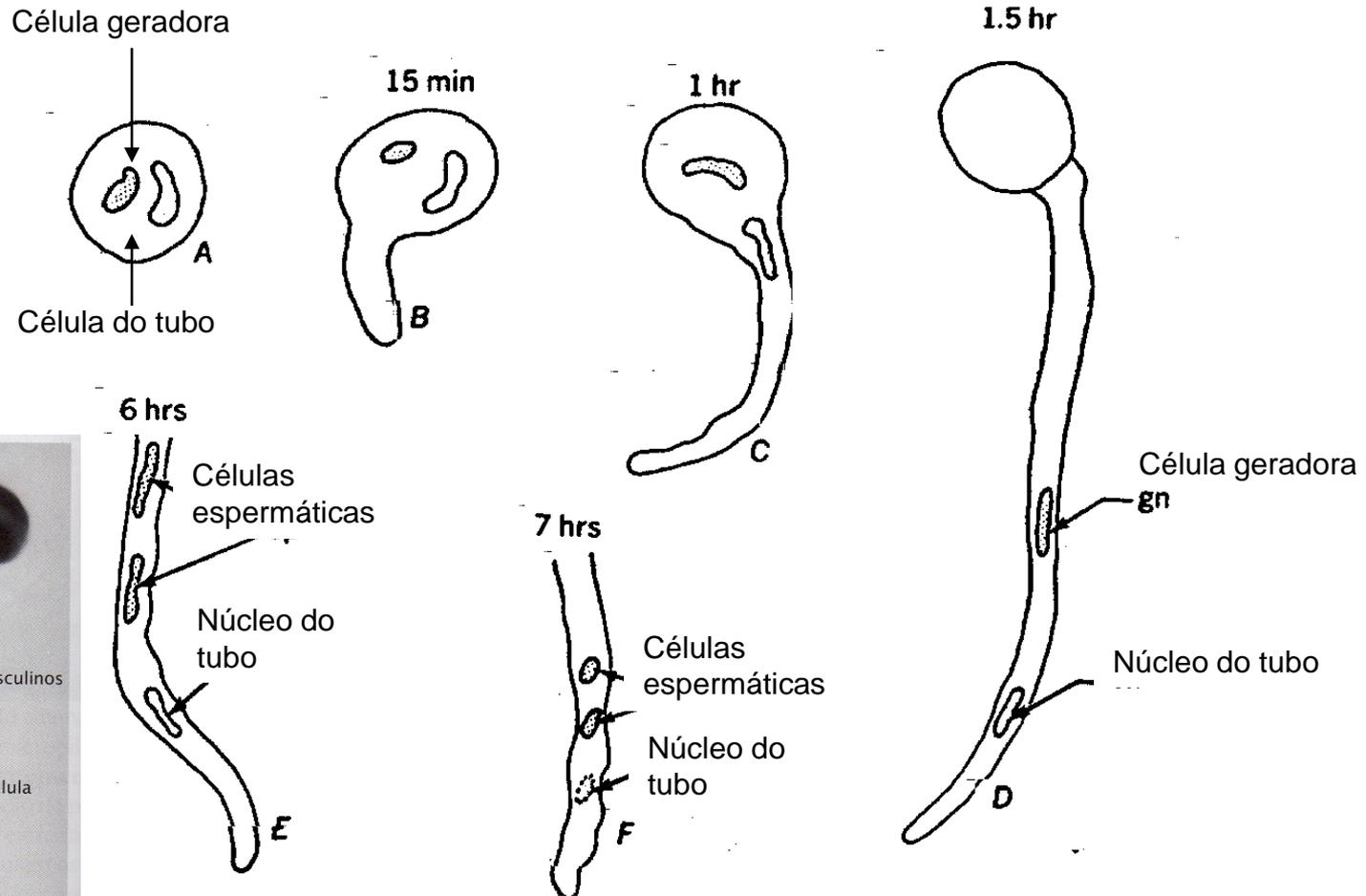


Figure 21.9 Germination of pollen grain of *Scilla* (monocotyledon) in vitro. Medium: 2% agar, 7% cane sugar, traces of sterile yeast. A, resting binucleate pollen grain, B–E, stages of germination at times after placement on medium indicated above the drawings. Only tips of the pollen tubes in E and F. The nuclei are compact at end of germination in F. Details: gn, generative nucleus; sp, sperm nucleus; vn, vegetative nucleus. (Adapted from R. A. Brink, *Amer. J. Bot.* 11:351–364, 1924.)

Raven et al. 2007

25 μm

Gametófito masculino maduro: Célula do tubo contendo 2 células espermáticas (gametas)

Núcleo da
célula do tubo

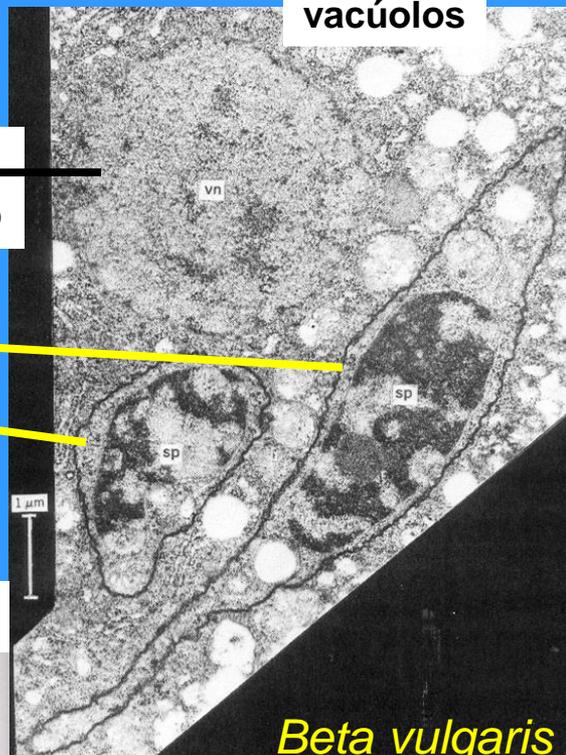


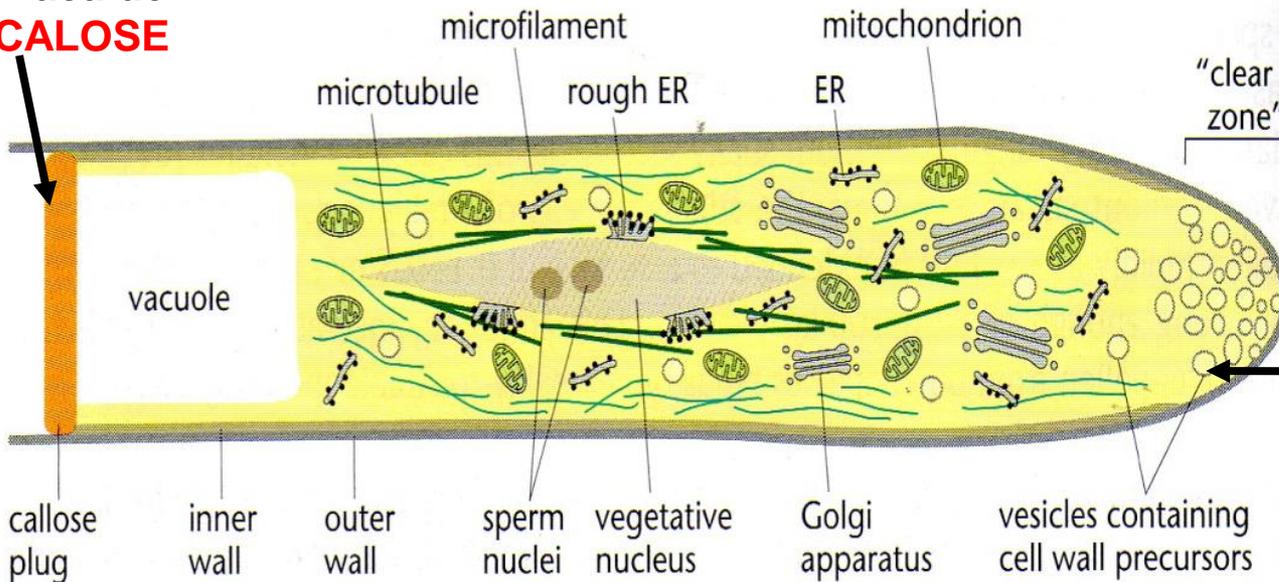
Figure 21.8 Electron micrograph of sperm cells (sp) and vegetative nucleus (vn) from a three-celled pollen grain of sugar beet (*Beta vulgaris*). The sperms are positioned at right angles to one another. They are delimited by two membranes interpreted as two plasma lemmas, the outer derived from the vegetative cell, the inner from the sperm cell. (From Hoefert.²⁹)

Tubo: parede celular majoritariamente de calose, carboidrato de baixo peso molecular, permite alongamento rápido - c.15 µm/minuto

***Nas gimnospermas a parede do tubo polínico é de celulose e pectina**

Célula do tubo cresce por distensão e adição de parede celular:

Placa de **CALOSE**



Smith et al. 2010

GINECEU

Constituído por um ou mais carpelos (= folhas carpelares)

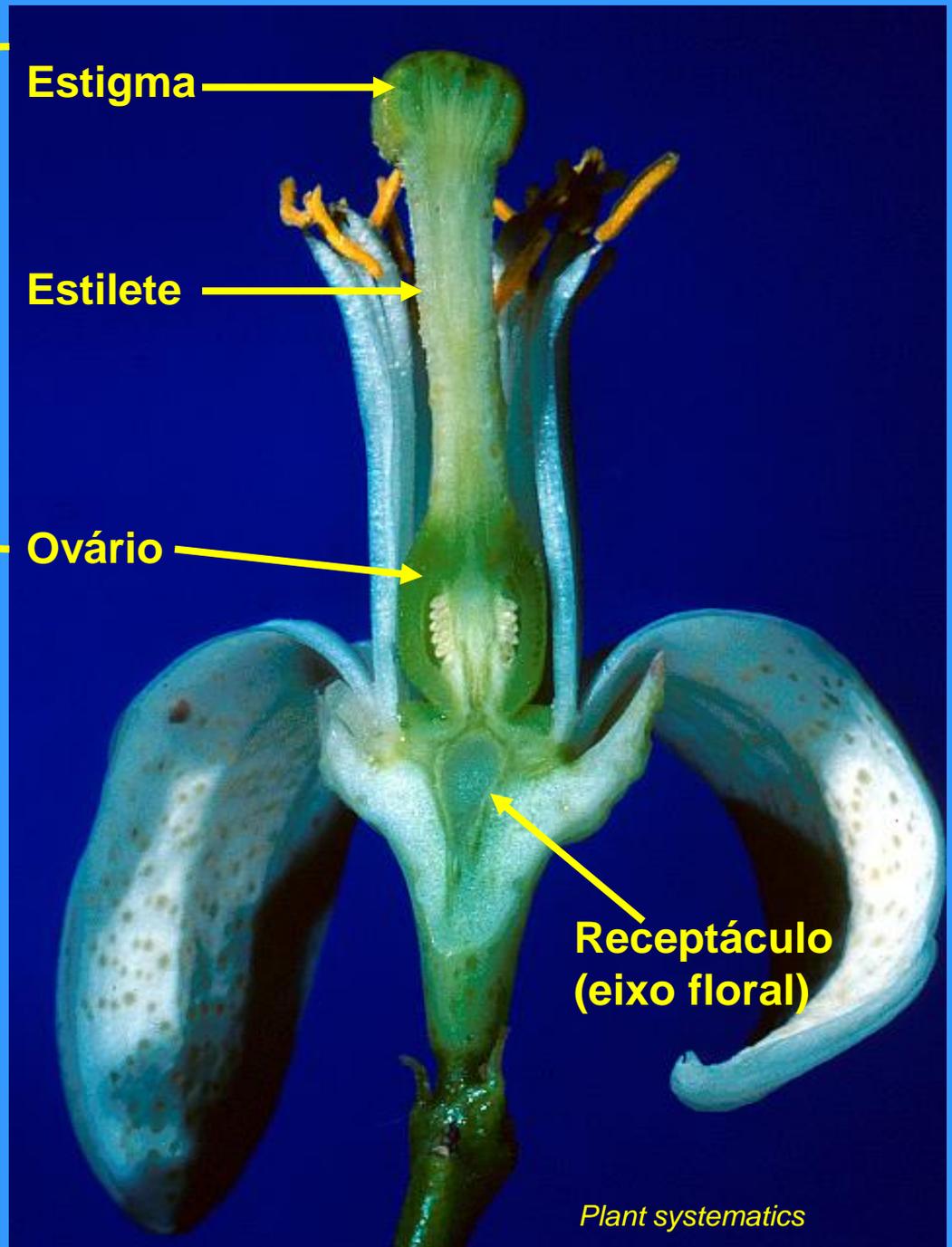
Estigma

Estilete

Ovário

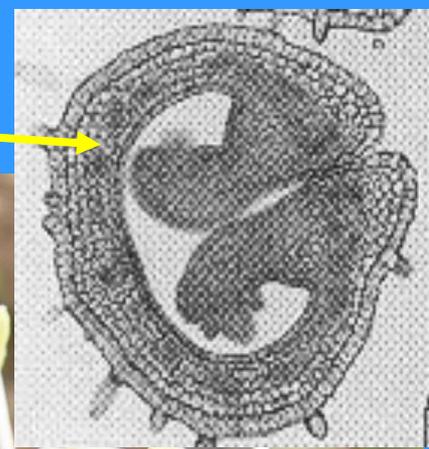
Receptáculo (eixo floral)

Citrus
Rutaceae



jatobá
Hymenaea stigonocarpa
Leguminosae

**Gineceu
unicarpelar**

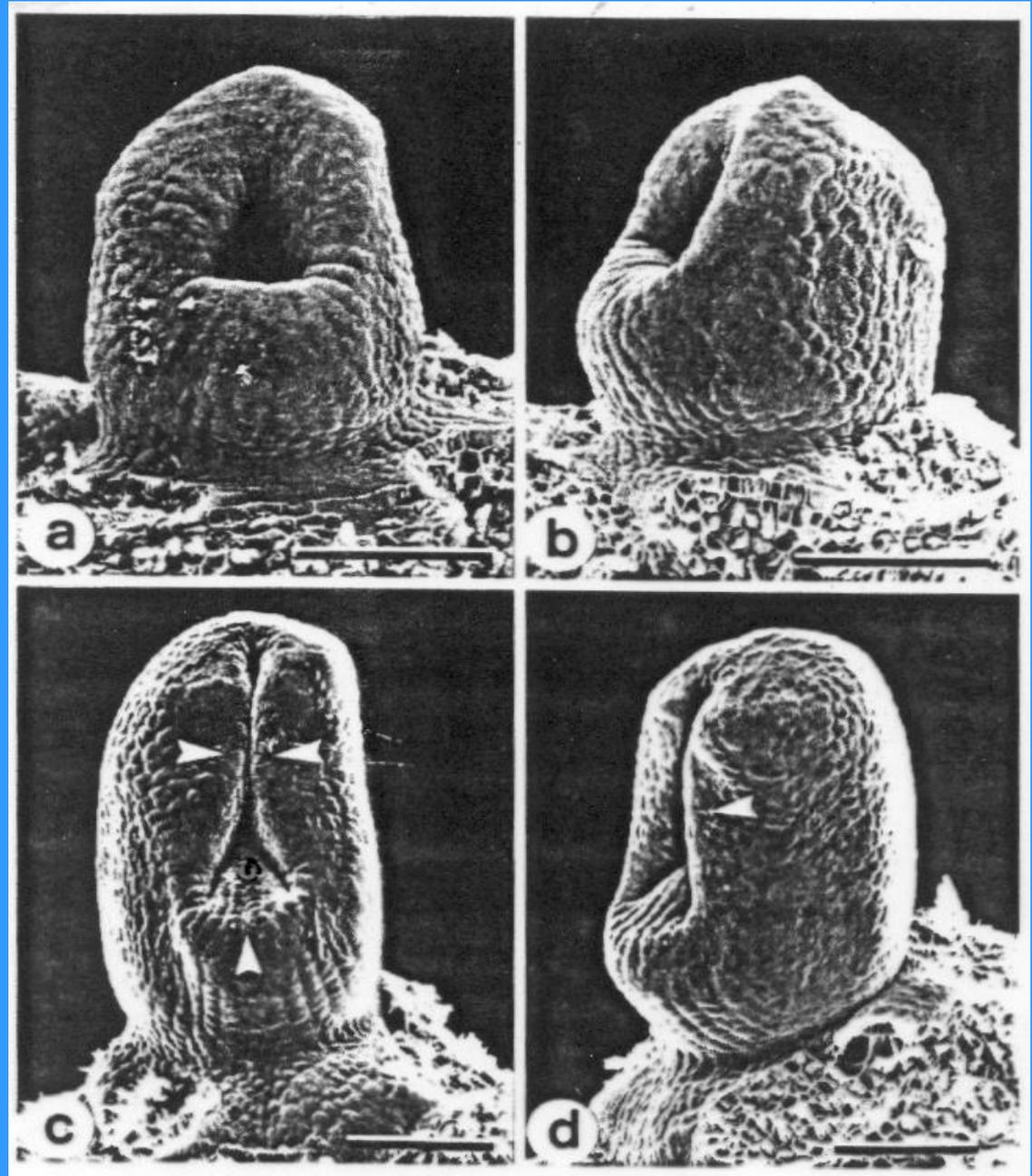


GINECEU

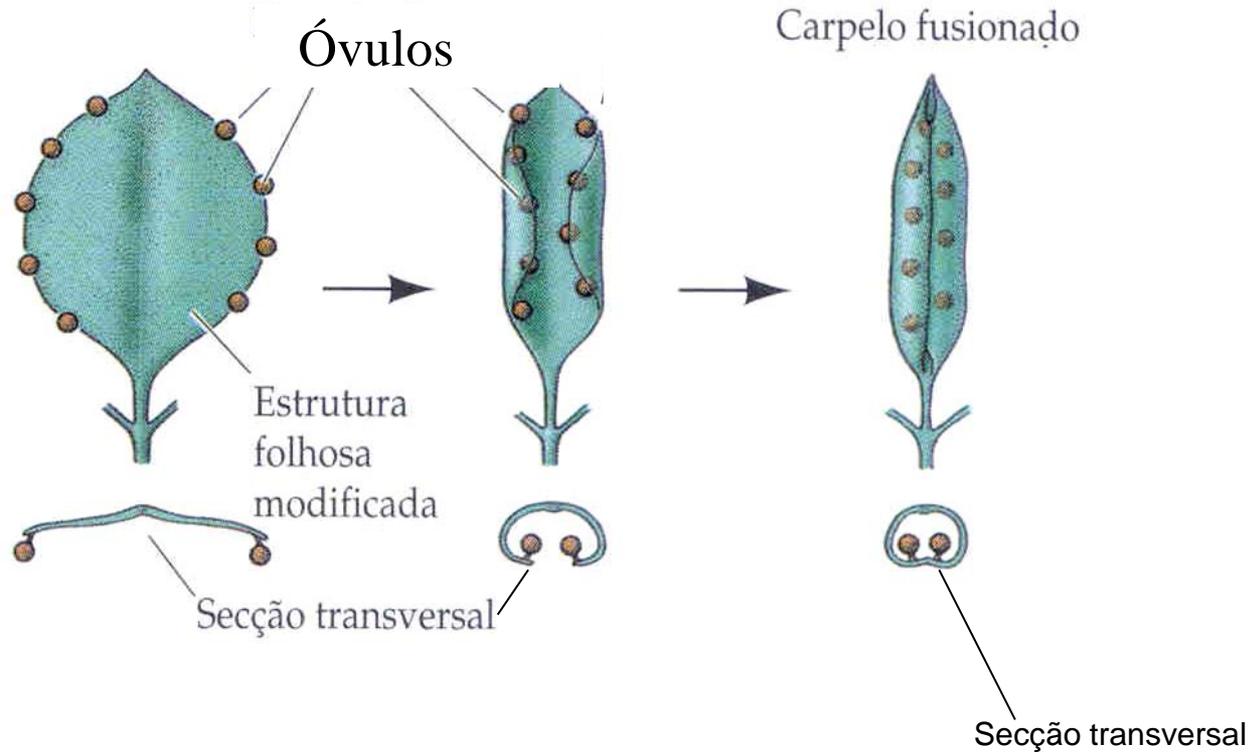
Fechamento
carpelar em
loureiro

Laurus nobilis
(Lauraceae)

Endress 1997

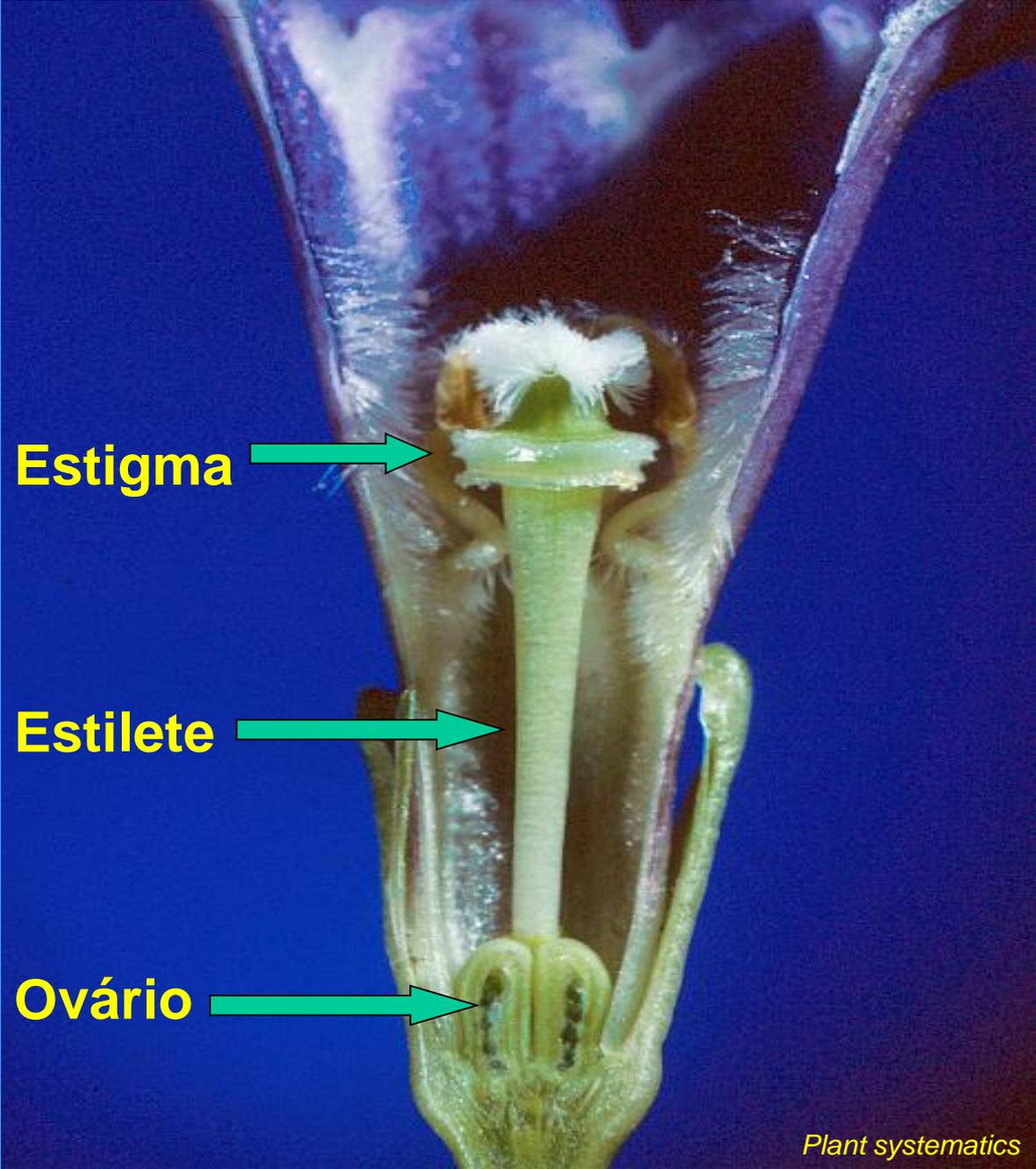


A origem do carpelo = folha modificada, ou uma escama ovulífera modificada?



GINECEU

Formado por um ou mais carpelos



ESTIGMA

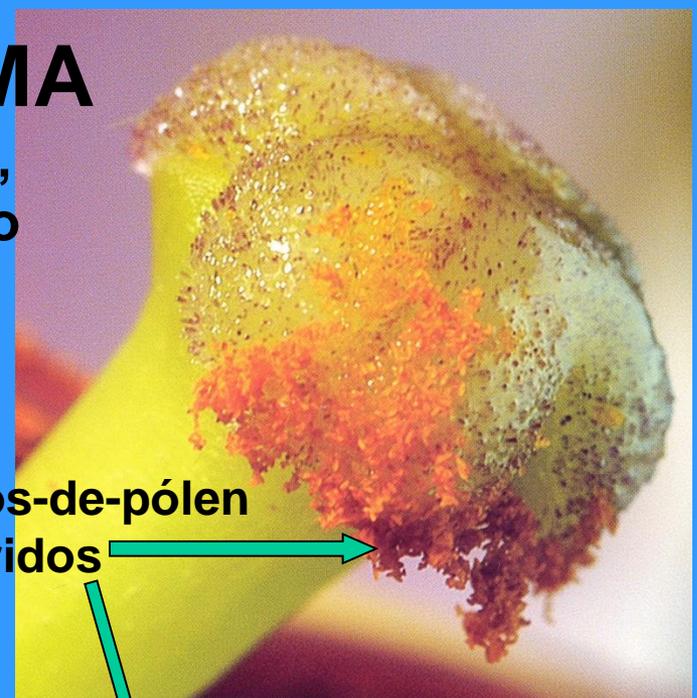
papiloso,
receptivo

Gineceu

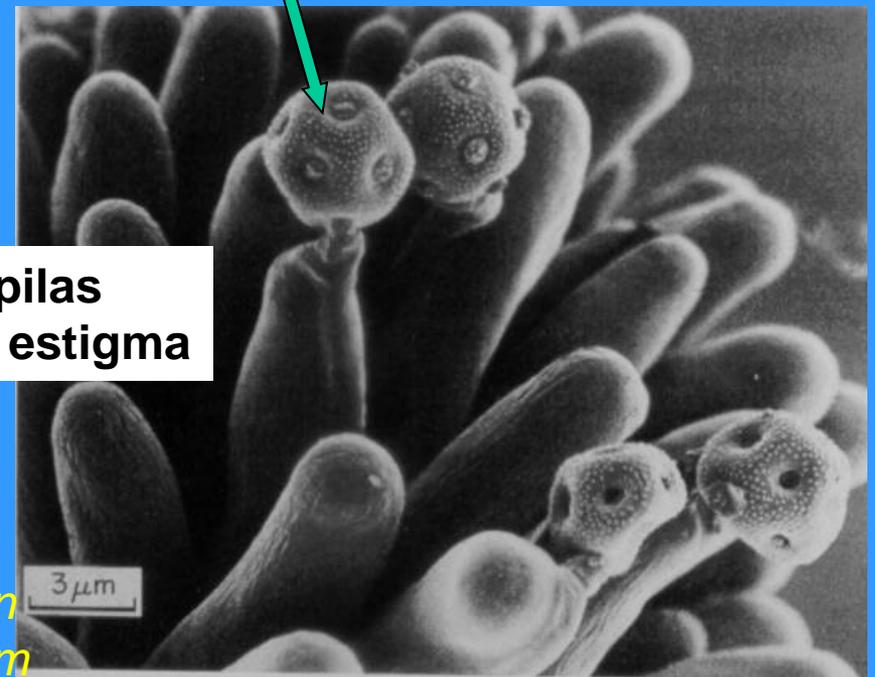
Vinca



Plant systematics



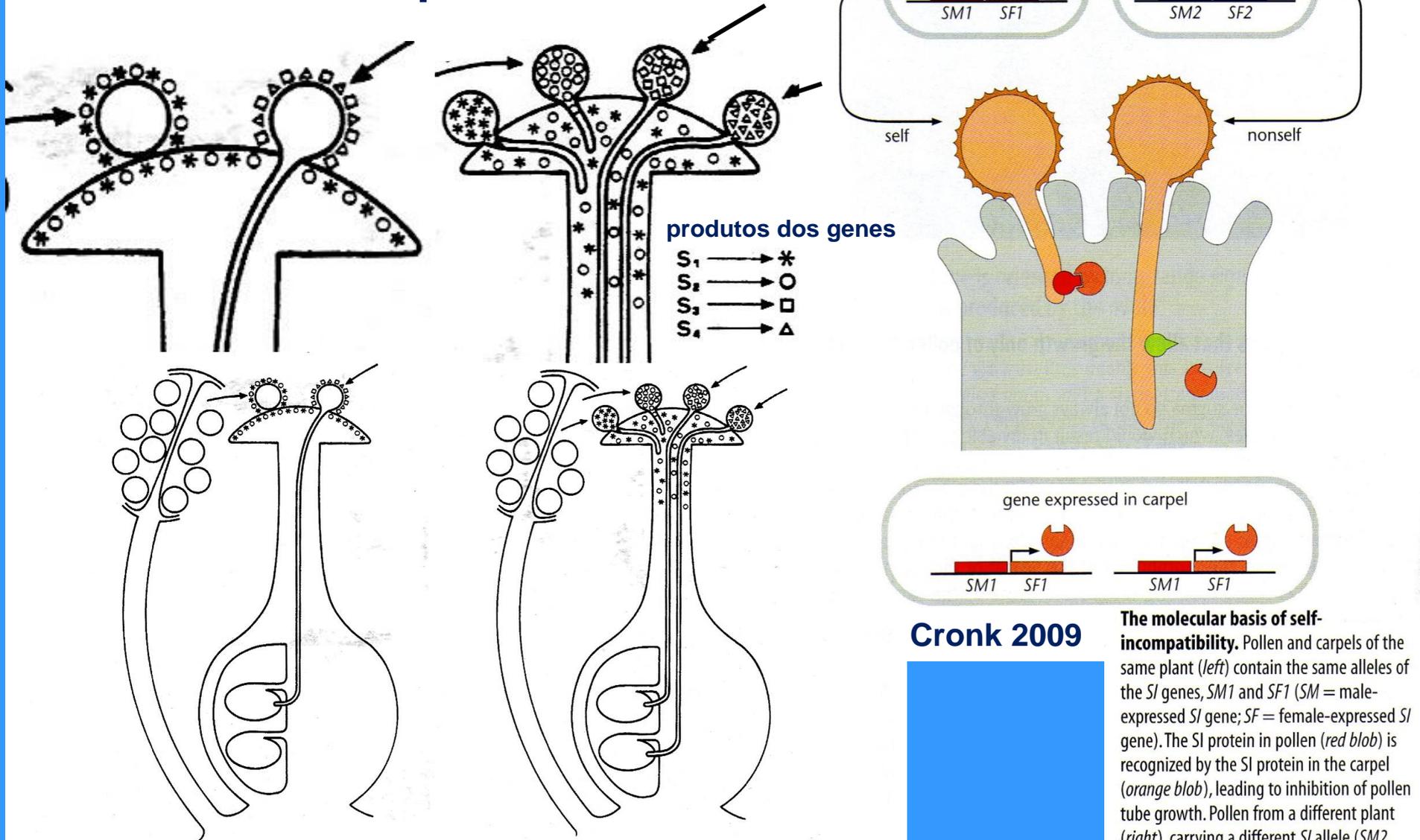
grãos-de-pólen
aderidos



papilas
do estigma

*Myosoton
aquaticum*

Autoincompatibilidade



Leins & Erbar 2010

Fig. 138. The principle of self-incompatibility. On the left: diploid (sporophytic) mechanism, on the right: haploid (gametophytic) mechanism. S = self-incompatibility gene; the symbols mark the gene products.

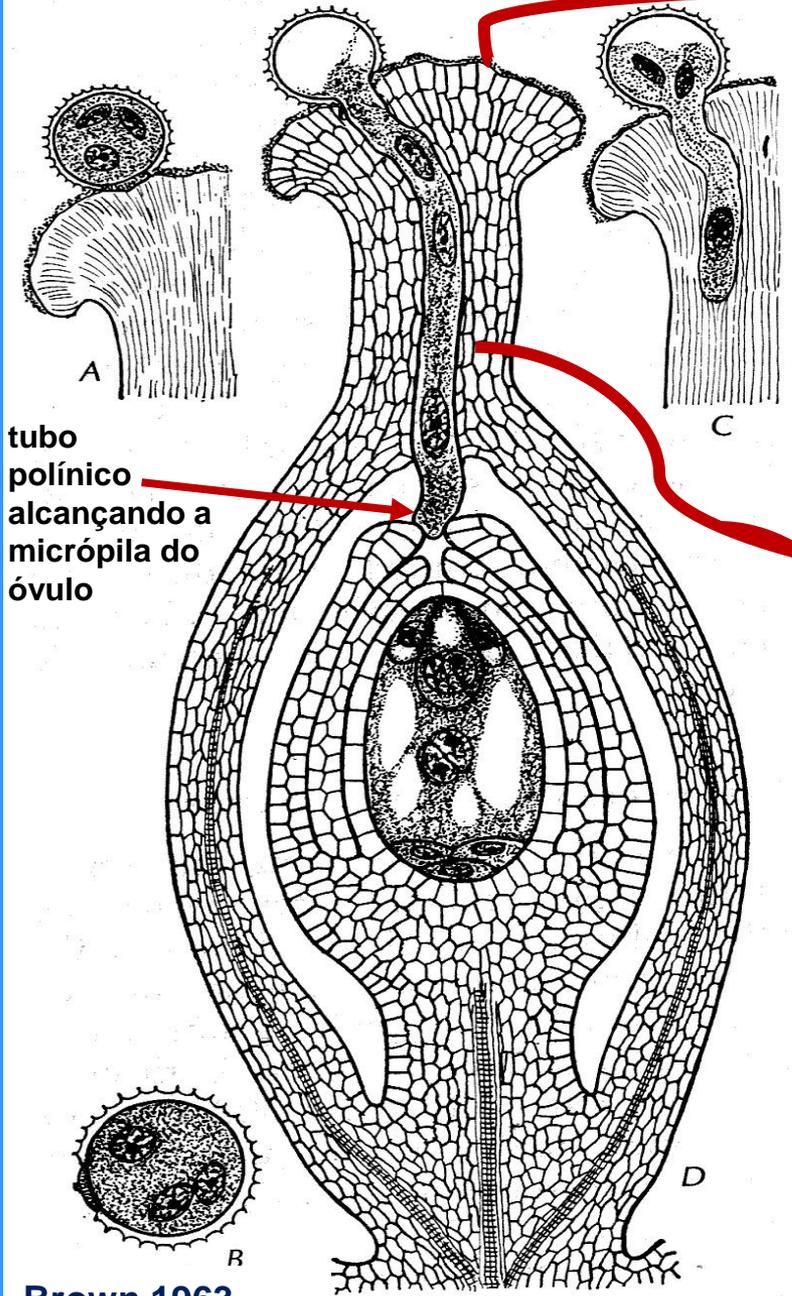
Cronk 2009

The molecular basis of self-incompatibility. Pollen and carpels of the same plant (left) contain the same alleles of the S_I genes, SM1 and SF1 (SM = male-expressed S_I gene; SF = female-expressed S_I gene). The S_I protein in pollen (red blob) is recognized by the S_I protein in the carpel (orange blob), leading to inhibition of pollen tube growth. Pollen from a different plant (right), carrying a different S_I allele (SM2, SF2), carries a protein (green blob) that is not recognized by the carpel protein, and pollen tube growth is not inhibited.

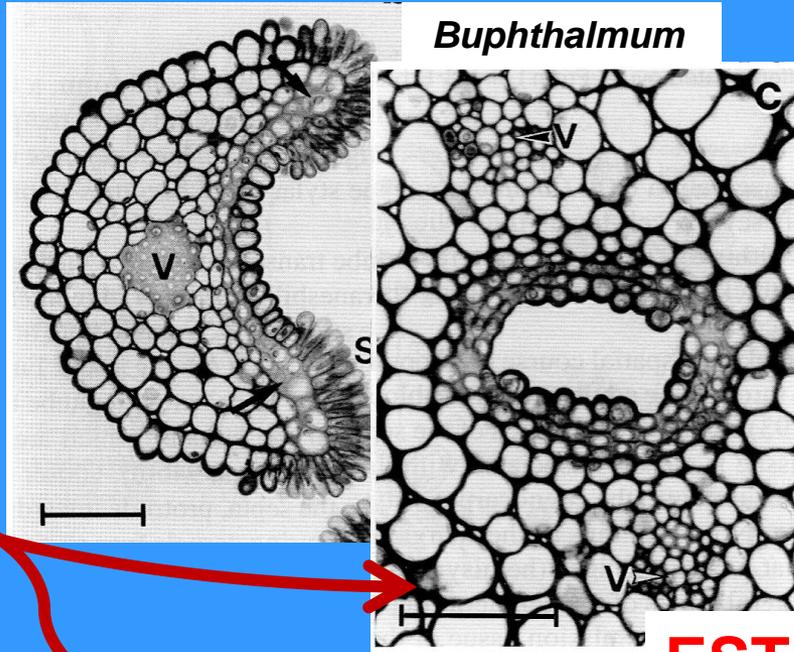
Gineceu - Tecidos de transmissão

ESTIGMA

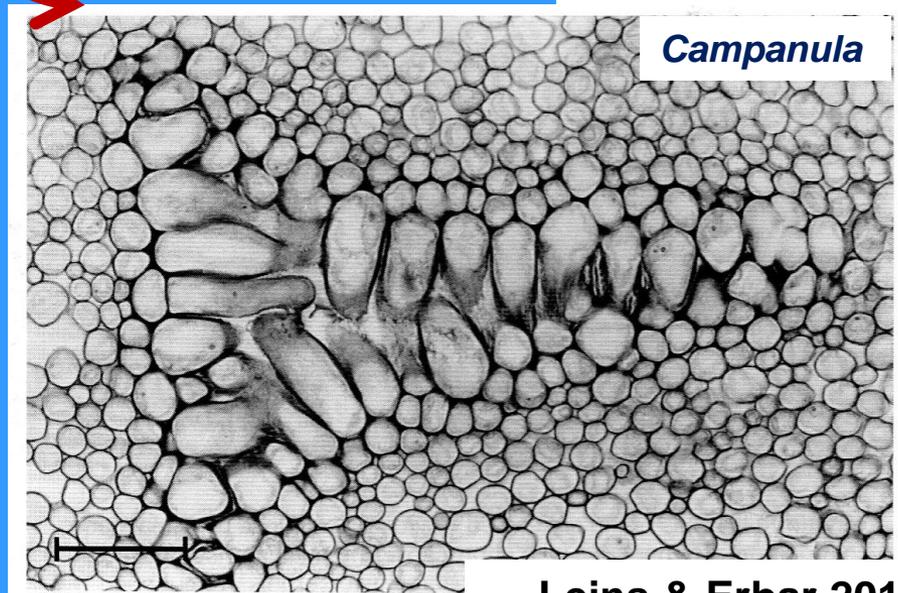
O tecido de transmissão é secretor e libera açúcares, facilitando a penetração dos tubos polínicos, até alcançar a(s) micrópila(s)



Brown 1963

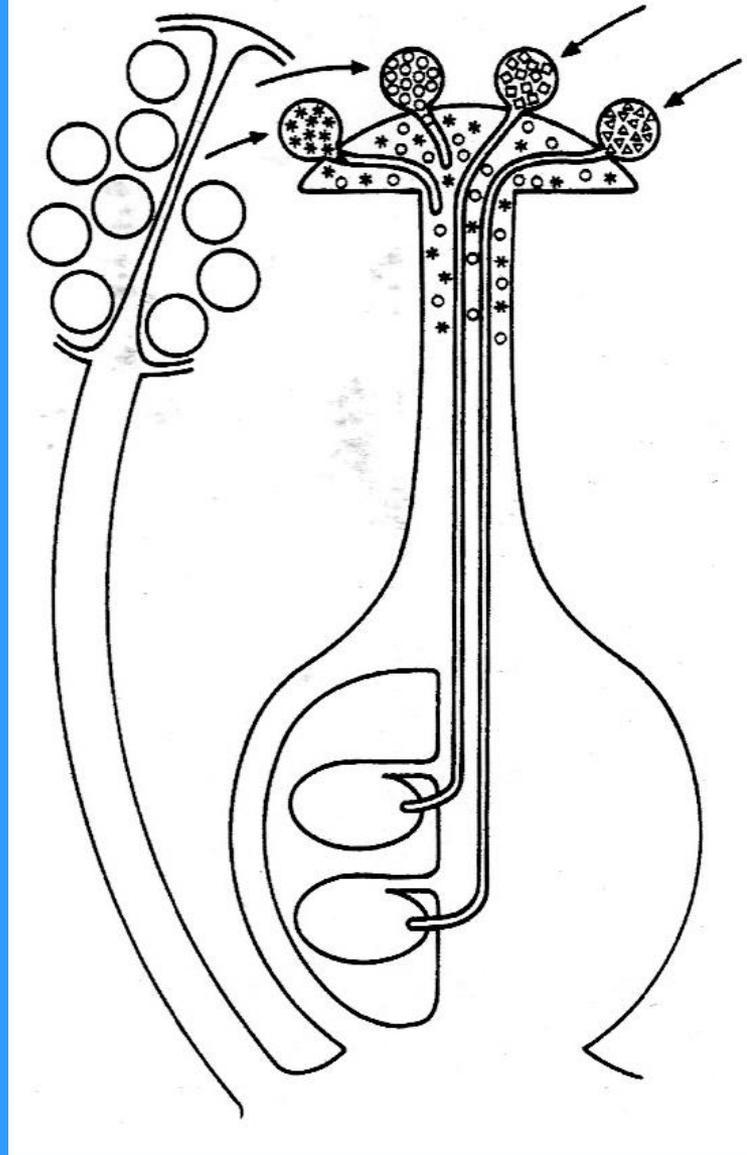
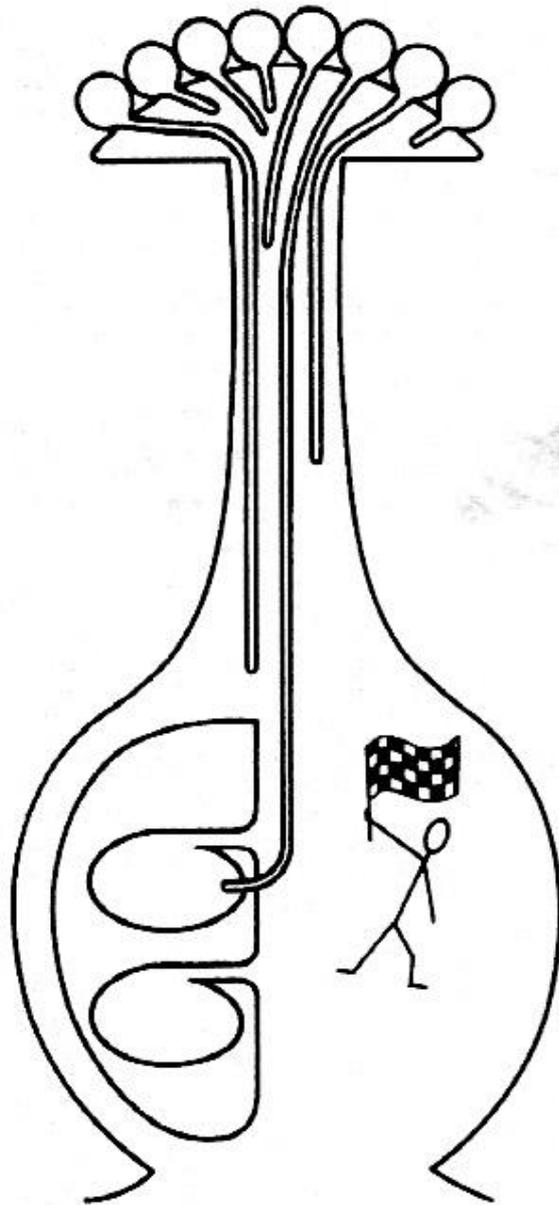


ESTILETE



Leins & Erbar 2010

Gineceu

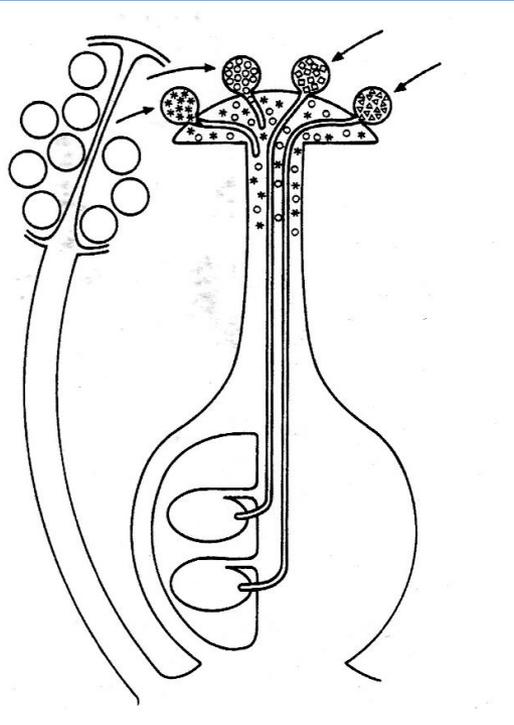


Leins & Erbar 2010

Fig. 161. Pollen tube competition in the pistil: Only the fastest pollen tubes are the “winners”!

Grãos de pólen (em cor amarelada) germinando sobre papilas de estigma (em cinza) de *Mimulus* (Phrymaceae)
(Evert & Eichhorn 2014)

Grãos de pólen de diferentes doadores podem fecundar óvulos adjacentes, que resultam em descendentes geneticamente distintos dentro de um fruto.



Gineceu – APOCARPIA

Carpelo único
ou carpelos livres entre si

Drymis winteri
(Winteraceae)



óvulo

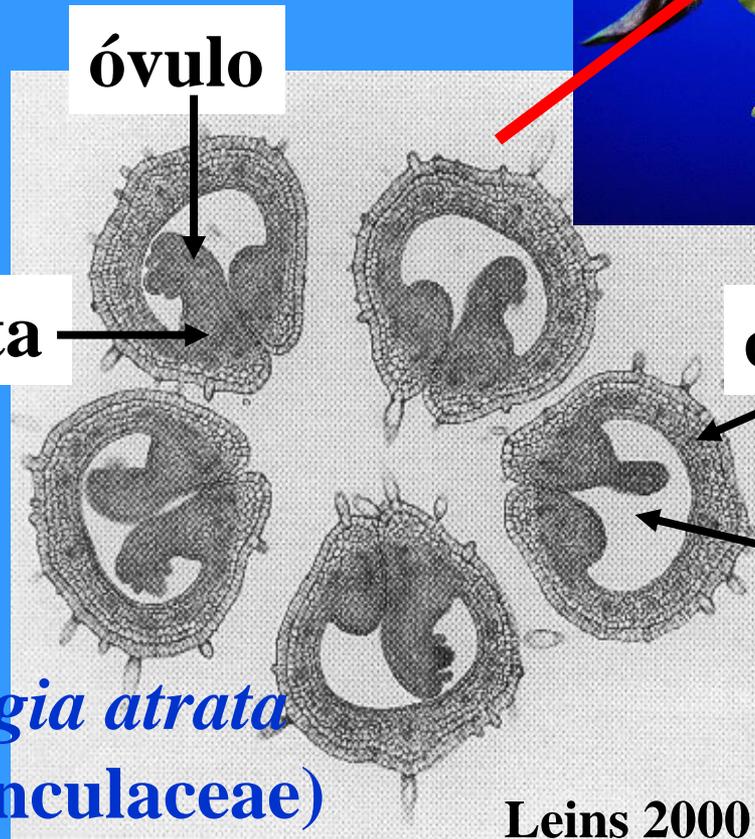
placenta

carpelo

lóculo
(cavidade)

Aquilegia atrata
(Ranunculaceae)

Leins 2000

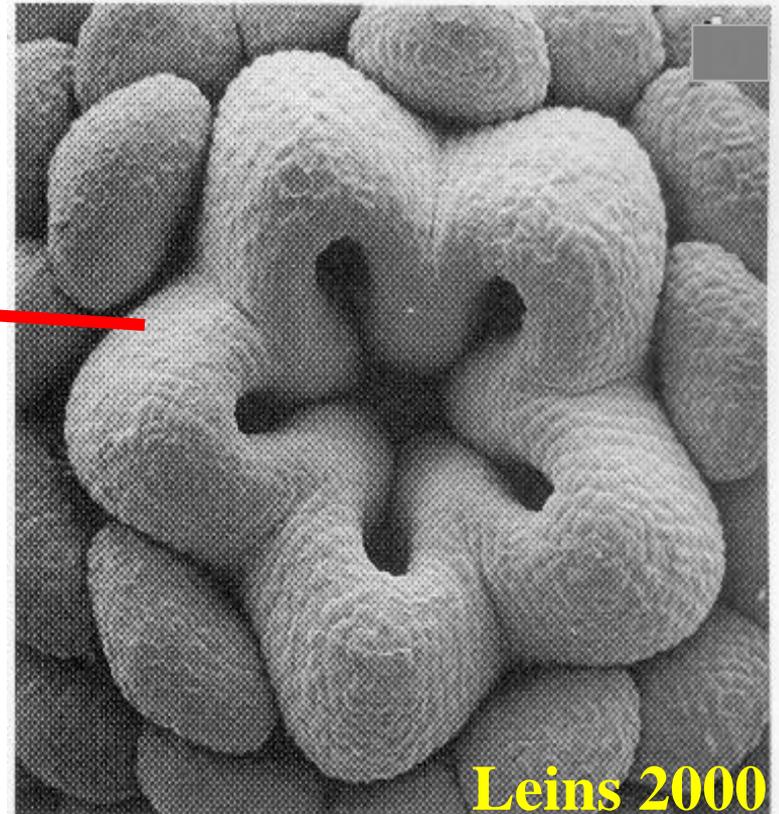


SINCARPIA - união entre carpelos possibilitada pela organização verticilada (cíclica) da flor

80% das angiospermas

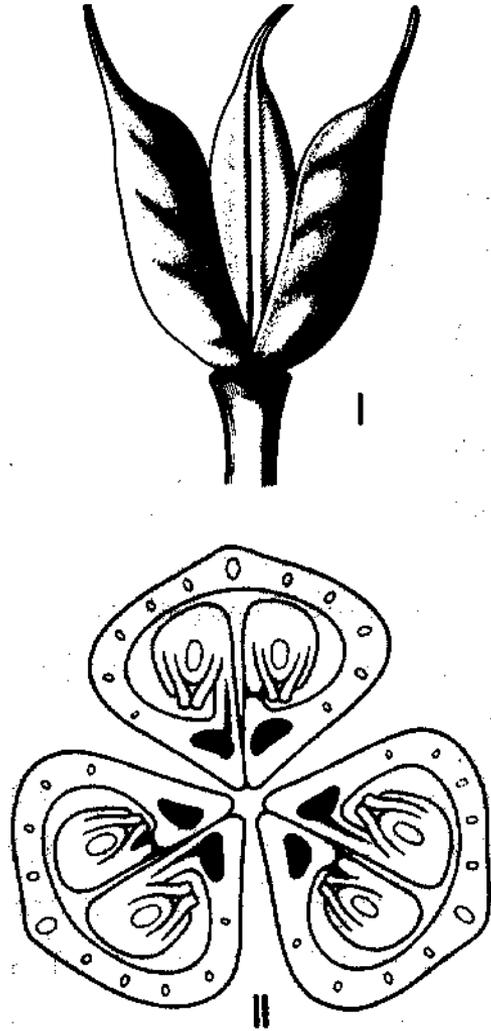


Hypericum hookerianum
(Hypericaceae)

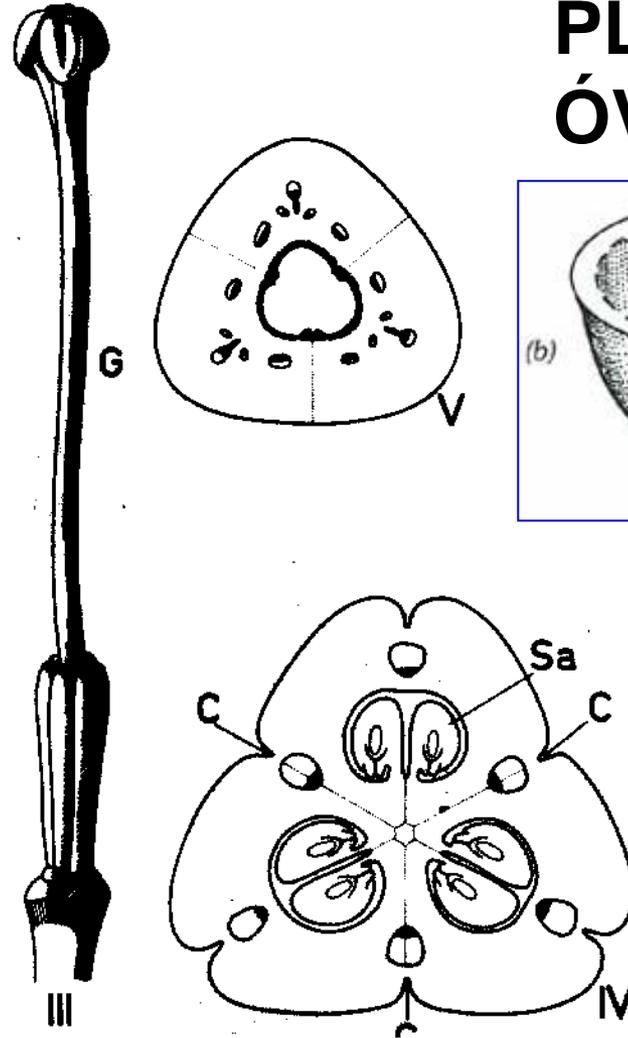


Estágio inicial de formação do gineceu:
5 carpelos unindo-se pelas margens

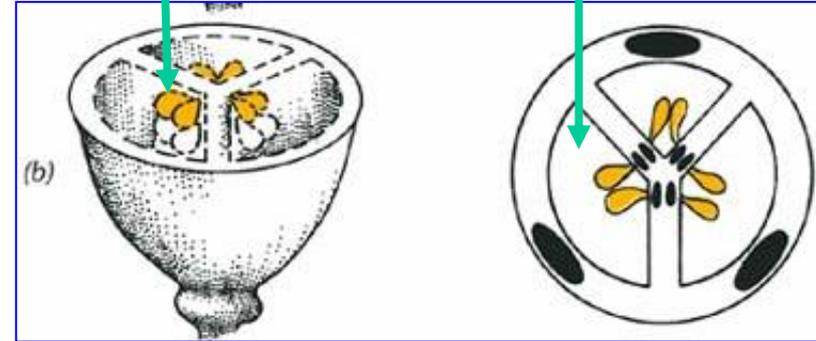
Gineceu APOCÁRPICO



Gineceu SINCÁRPICO



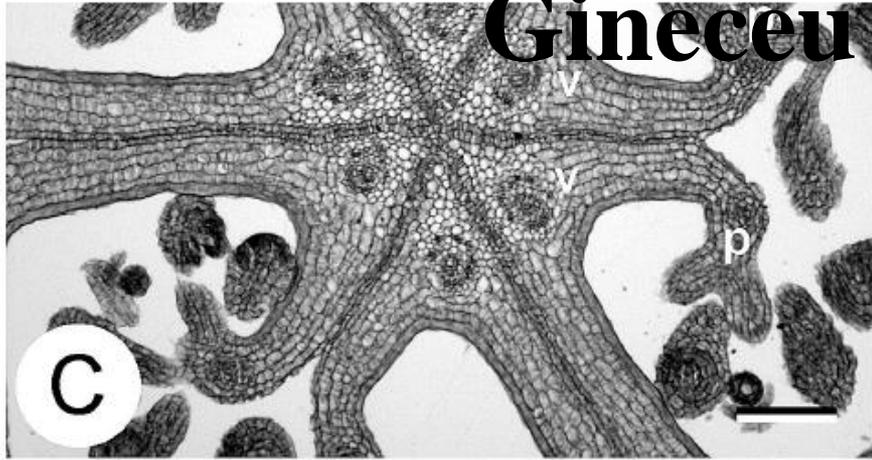
PLACENTA, ÓVULOS e LÓCULOS



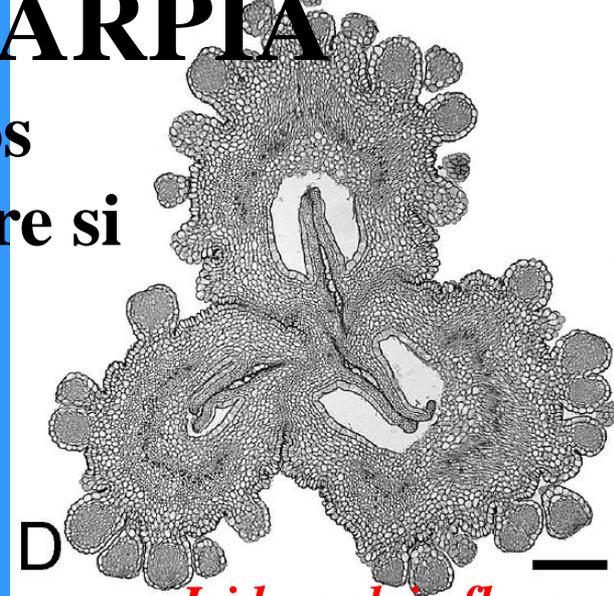
Liliaceae

Gineceu – SINCARPIA

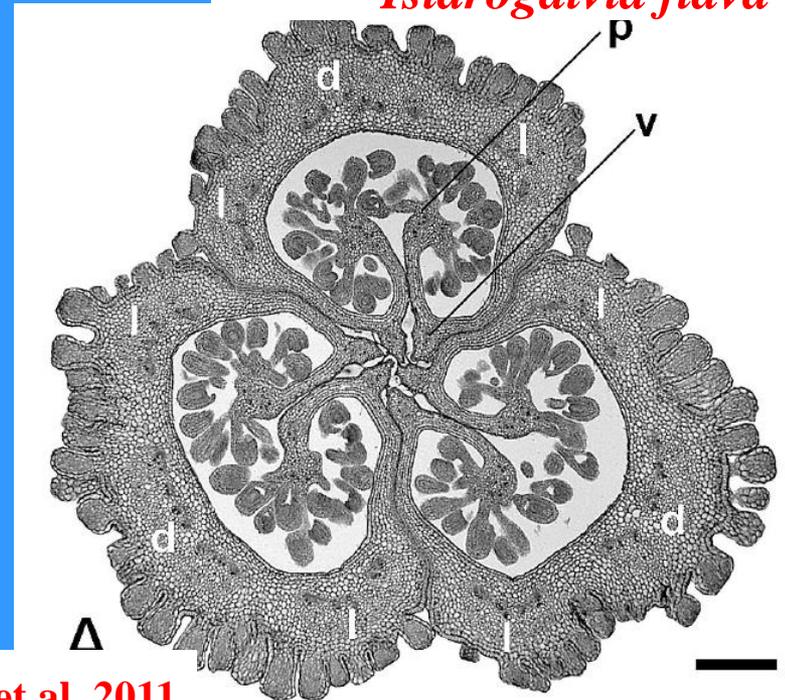
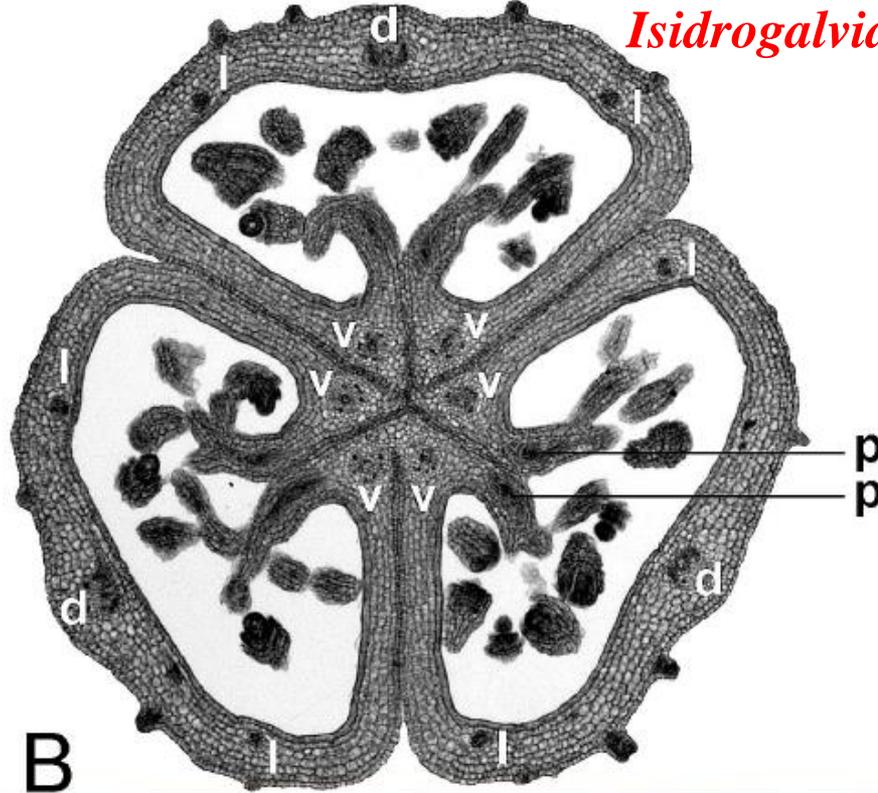
Carpelos
unidos entre si



Isidrogalvia robustior

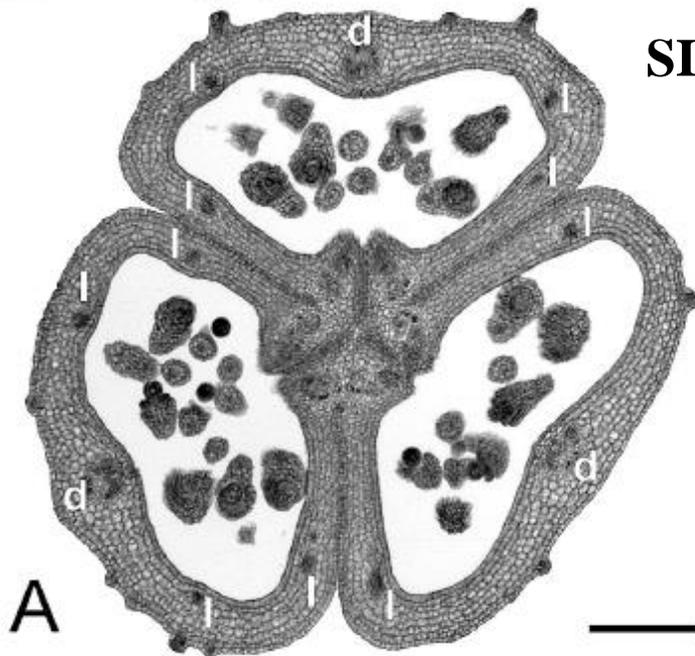
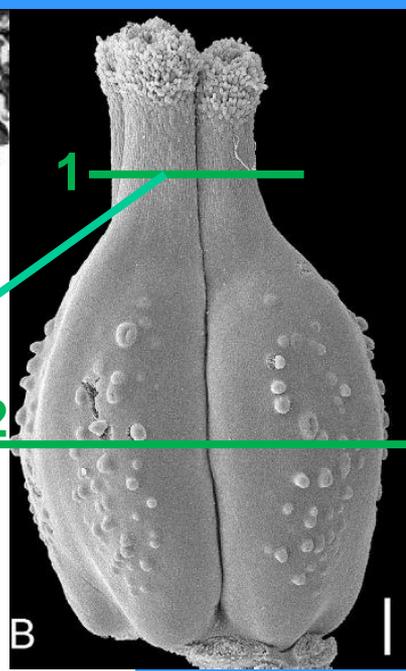
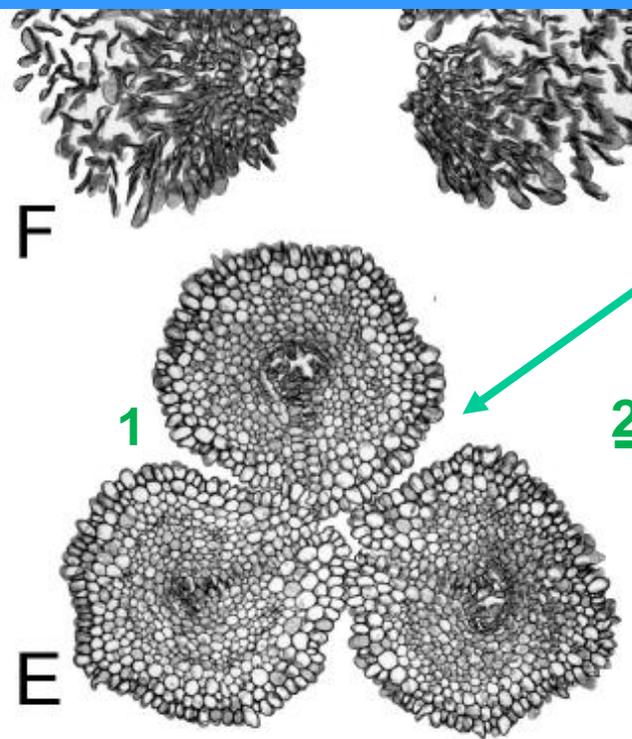
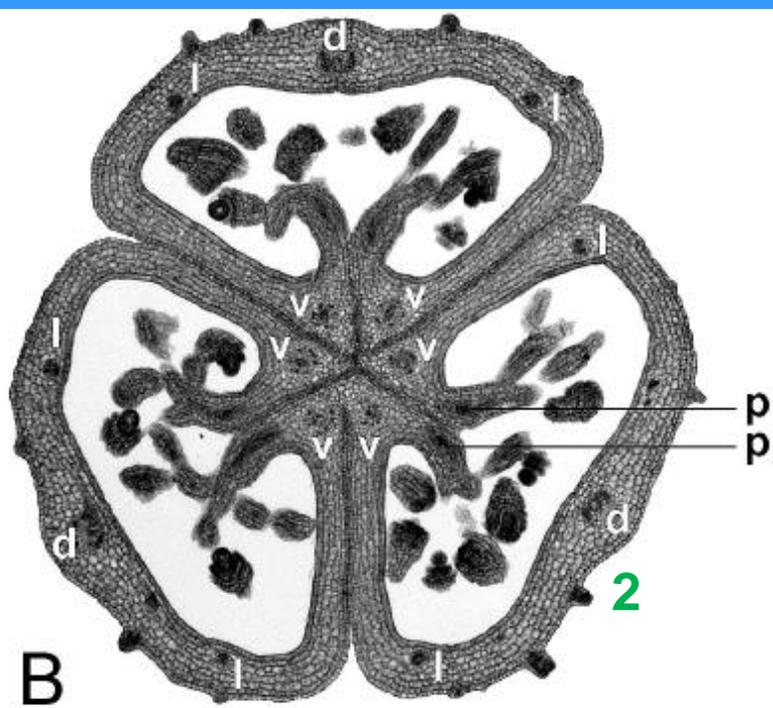


Isidrogalvia flava

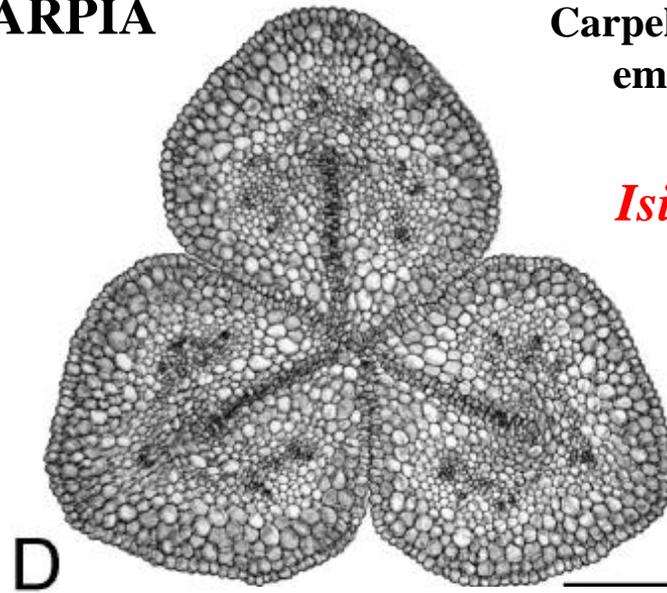


Tofieldiaceae -Alismatales

Remizowa et al. 2011



SINCARPIA



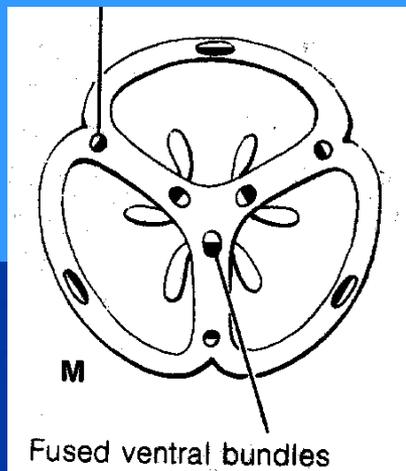
Carpelos unidos entre si em toda extensão

Isidrogalvia

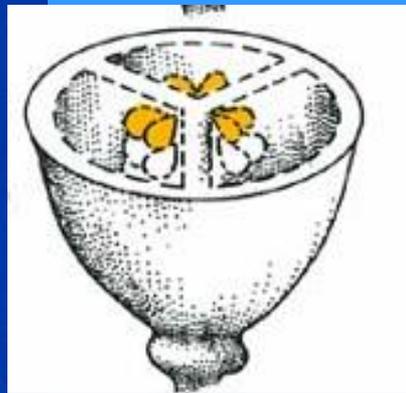
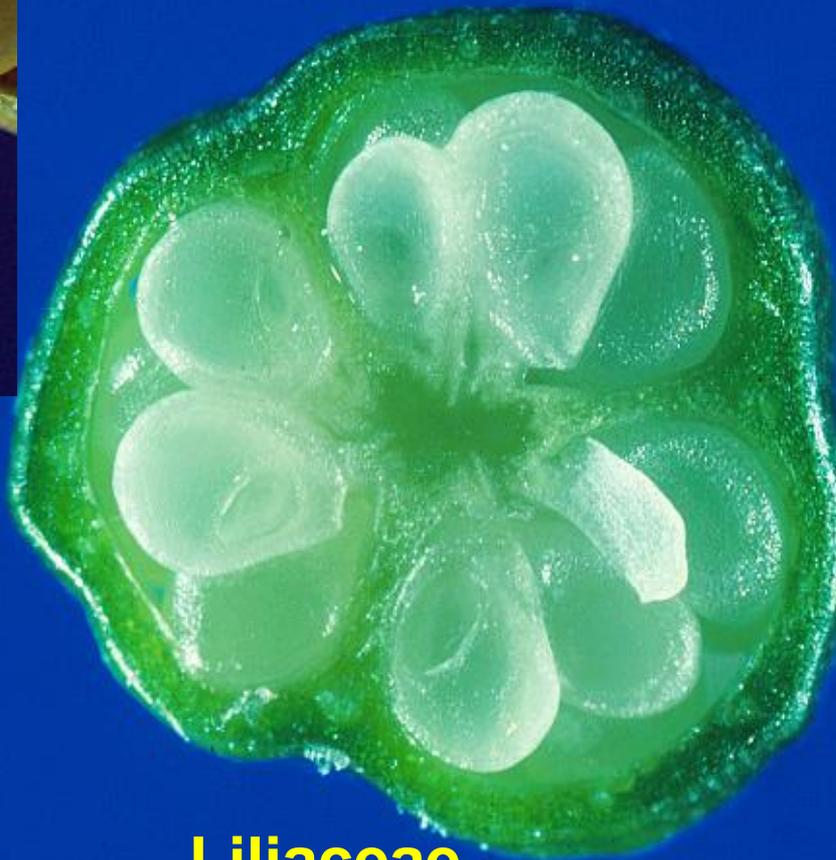
Tofieldiaceae

Remizowa et al. 2011

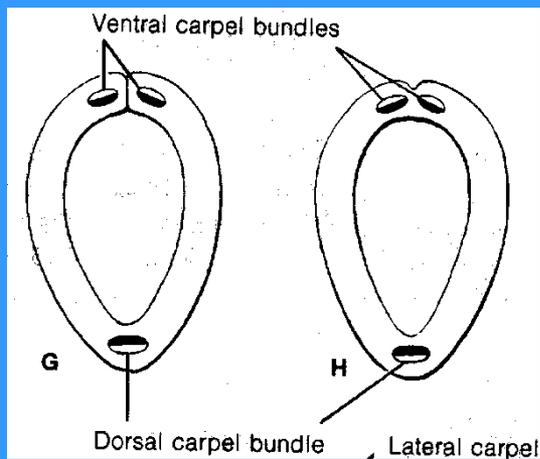
Gineceu apocárpico



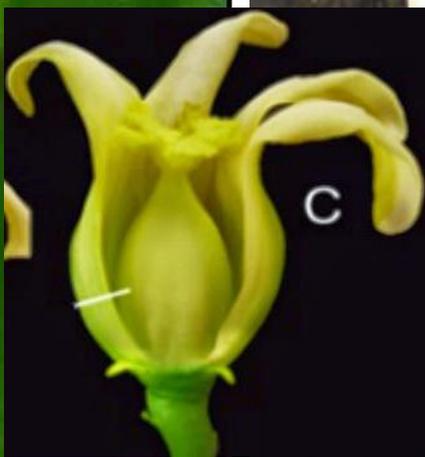
Gineceu sincárpico



Winteraceae



Liliaceae



Ovário sincárpico

Lóculo

5 carpelos unidos pelas margens; óvulos numerosos

Mamão WorldPress.com

Carica papaya, Caricaceae

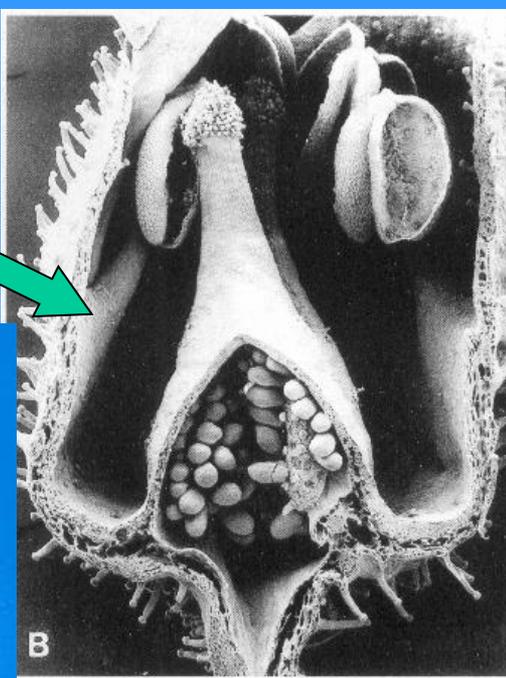


Plant systematics

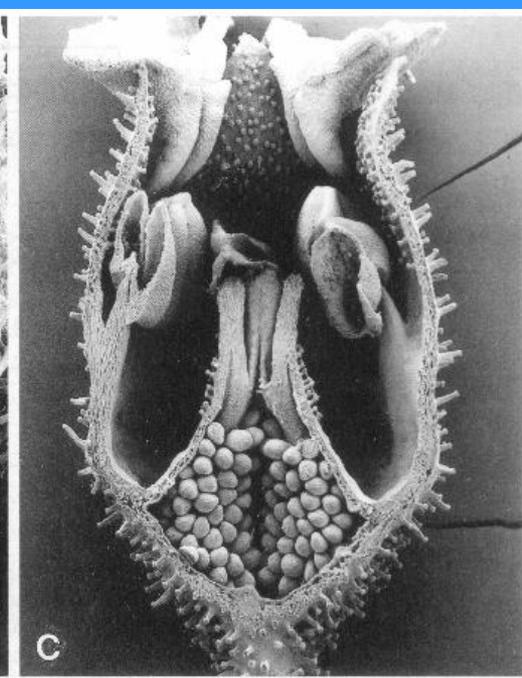
Hipanto
(tubo floral)



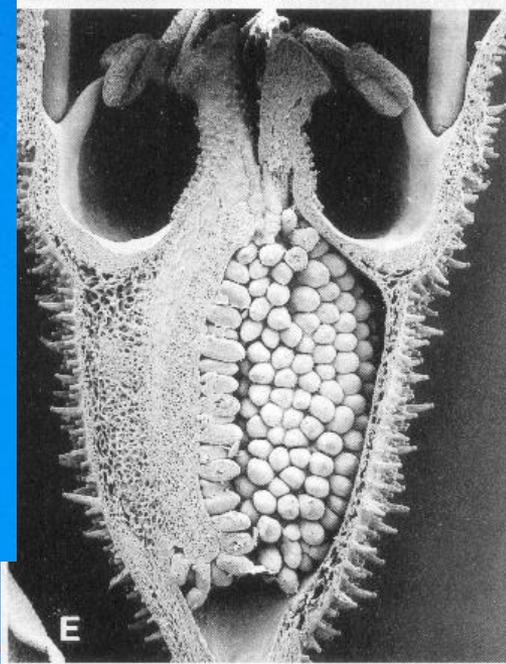
Lithophragma
Saxifragaceae



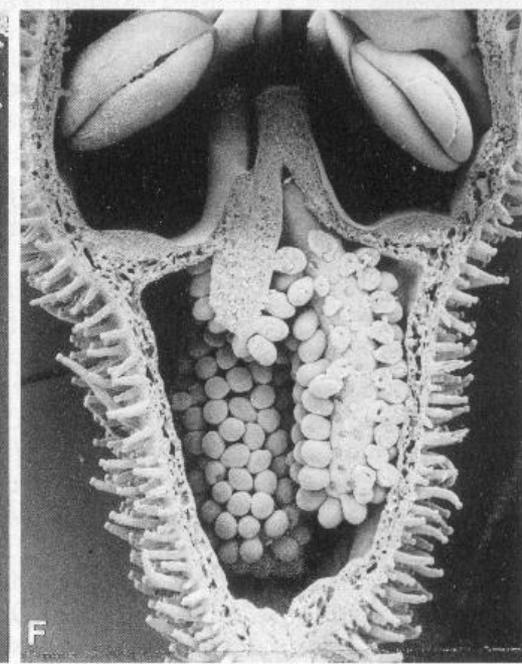
B



C



E



F

Citrus
Rutaceae
Flor sem
hipanto

Flores com hipanto



**Ovário
súpero**

(= livre do hipanto)

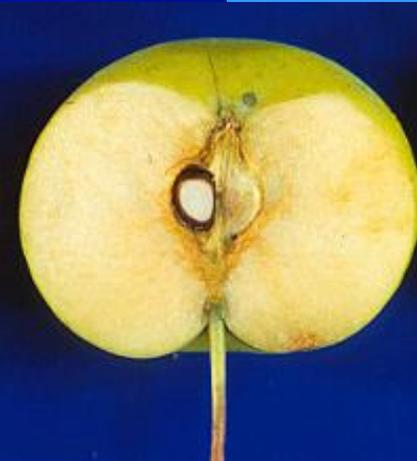
Prunus
cereja



**Ovário
ífero**

(= unido ao hipanto)

Malus
maçã

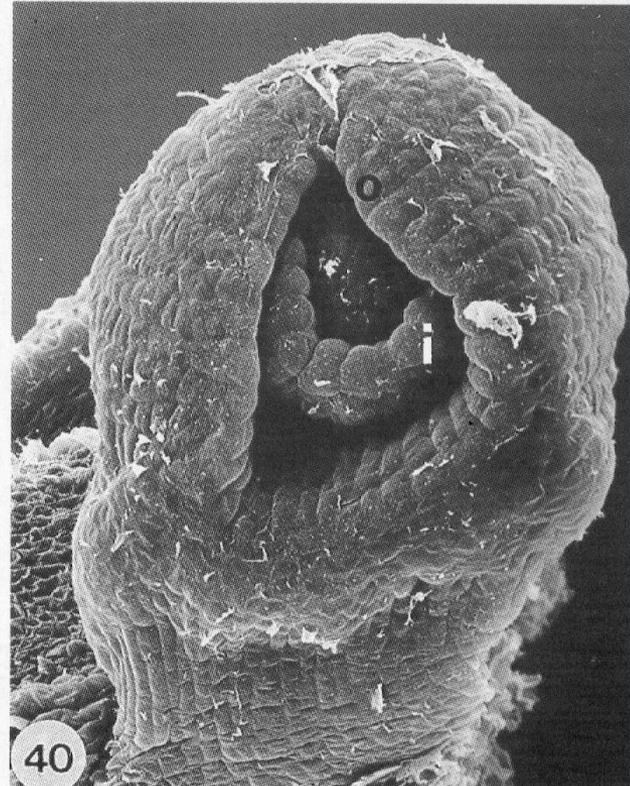
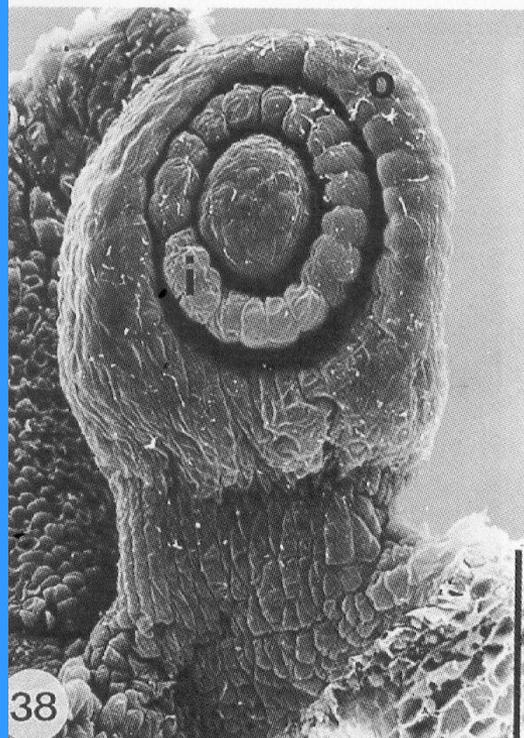
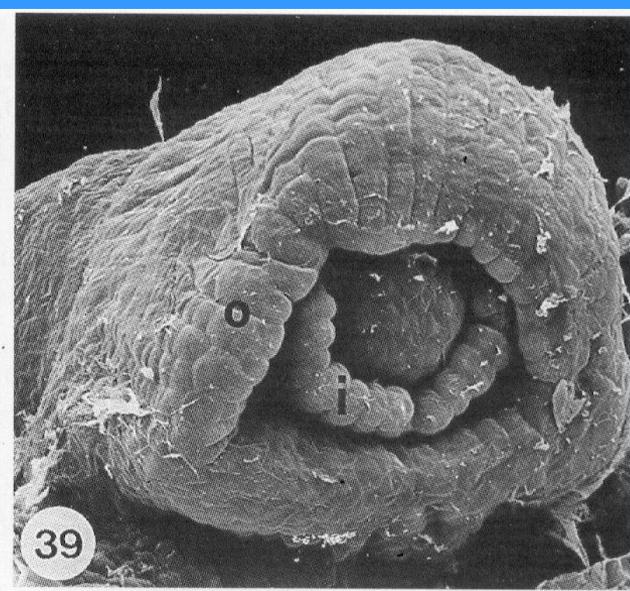
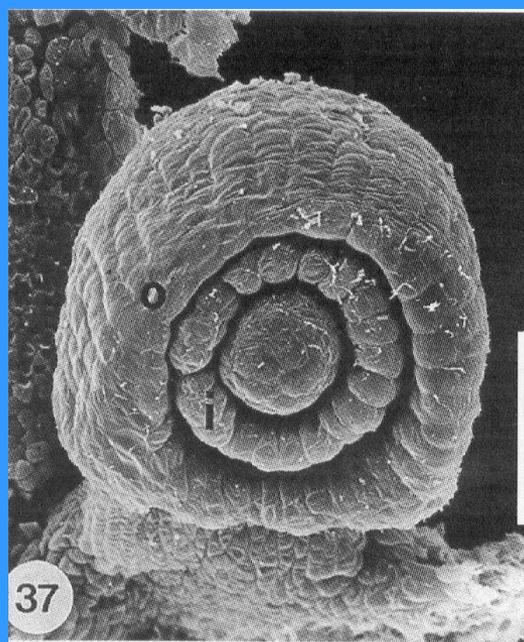


ÓVULO

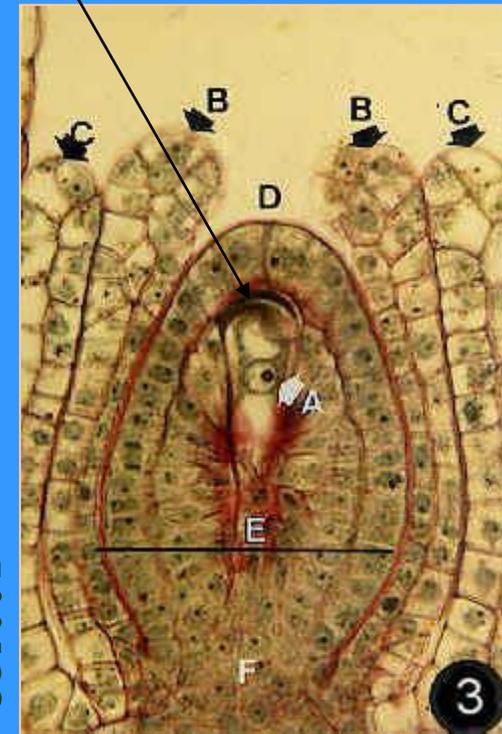
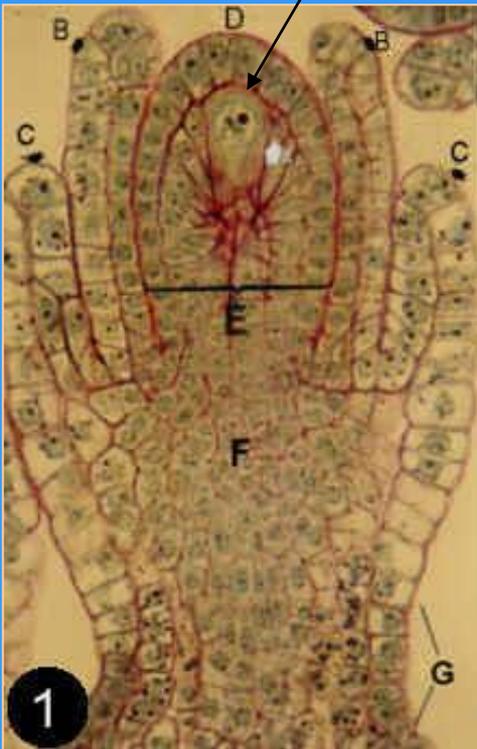
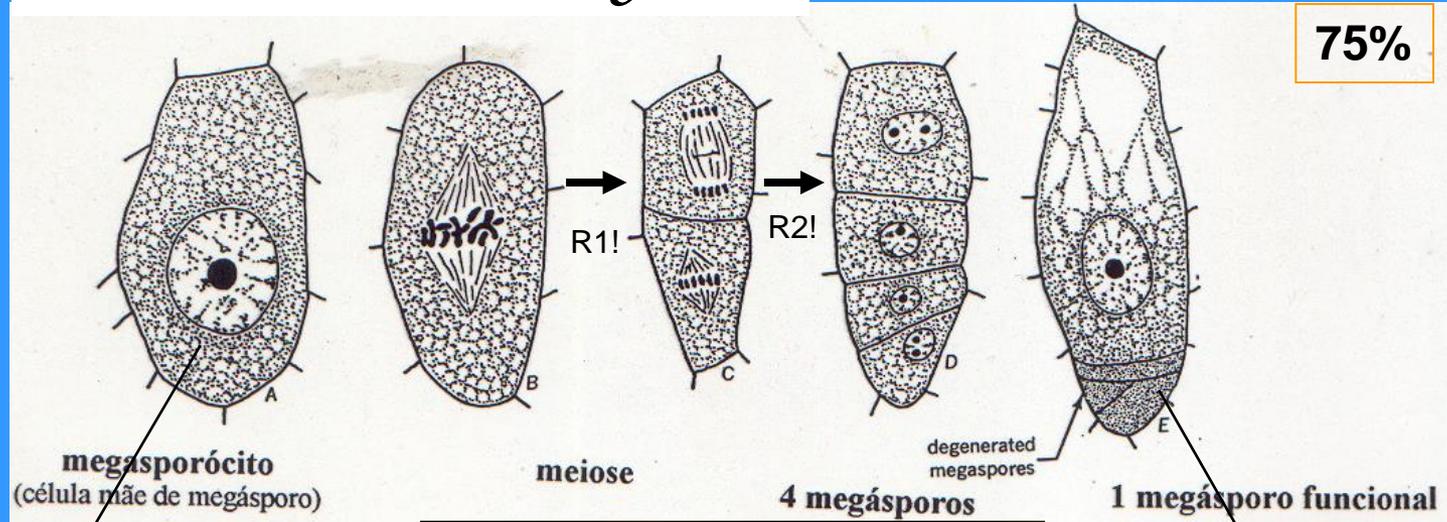
2 tegumentos
em angiospermas
(sinapomorfia)

Canella alba
Canellaceae

Igersheim &
Endress 1997



Meiose em *Mayaca*

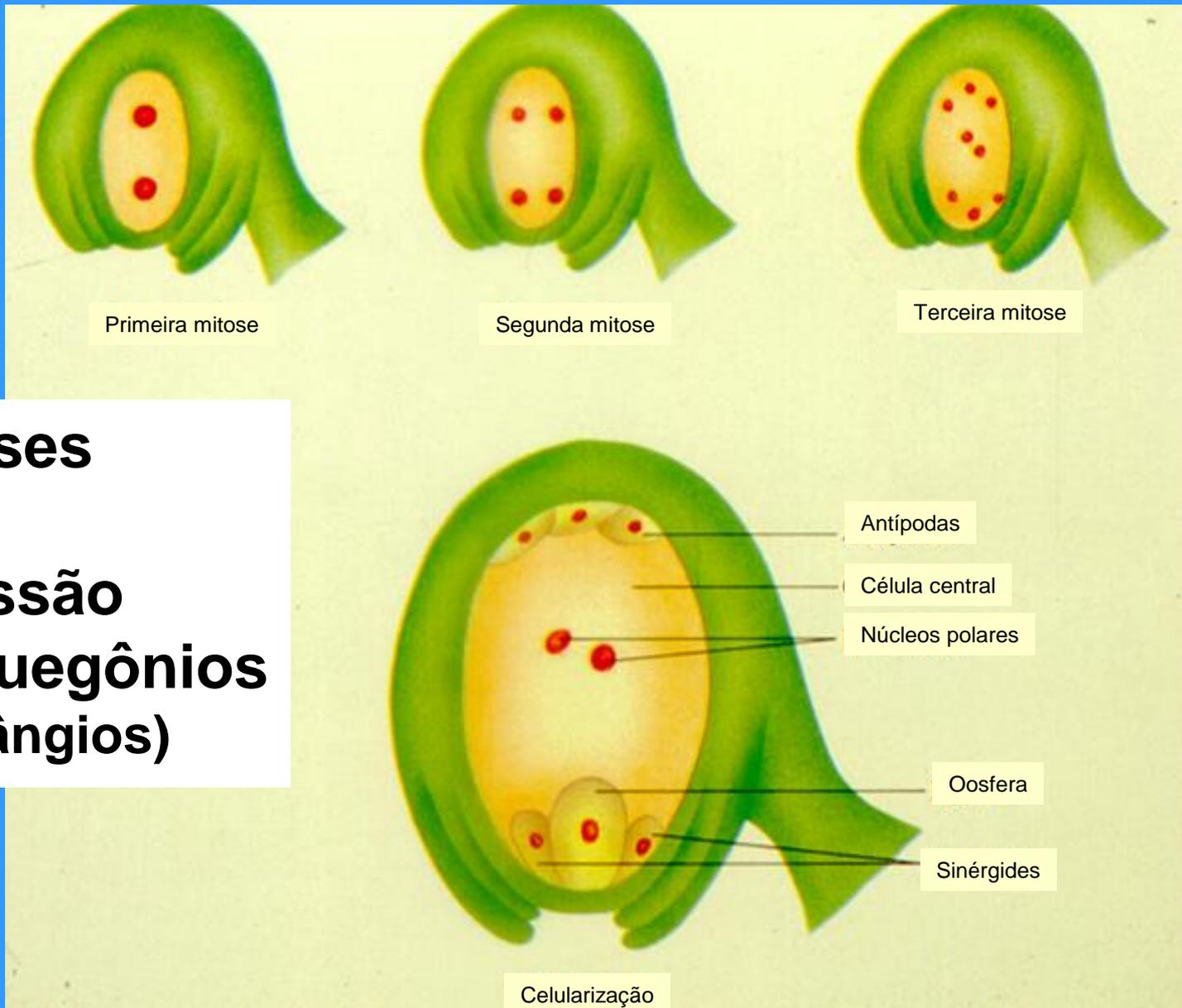


A = célula-mãe de megásporo
B = tegumento interno
C = tegumento externo
D = região da micrópila
E = megasporângio (nucelo)
F = calaza (em formação)
G = funículo

A = megásporo funcional
B = tegumento interno
C = tegumento externo
D = micrópila
E = megasporângio (nucelo)
F = calaza

Venturelli 1996

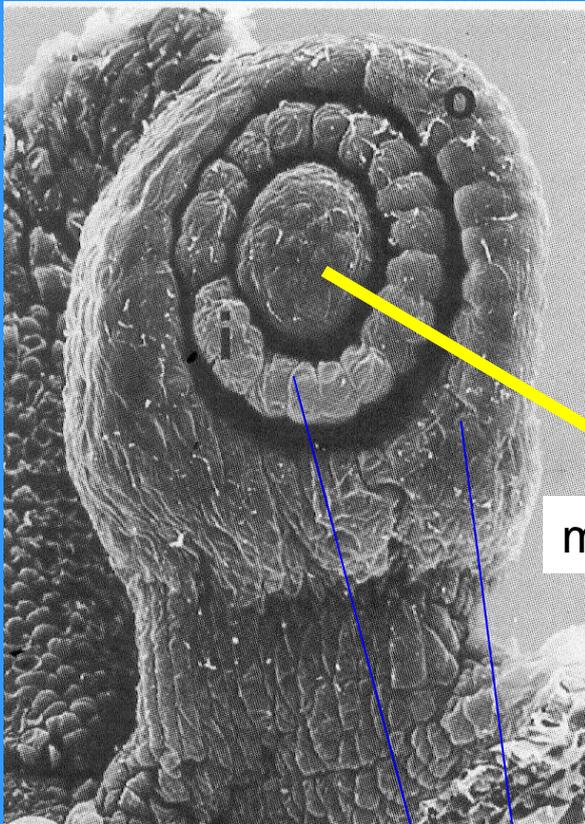
Formação do gametófito feminino



3 mitoses

**Supressão
de arquegônios
(gametângios)**

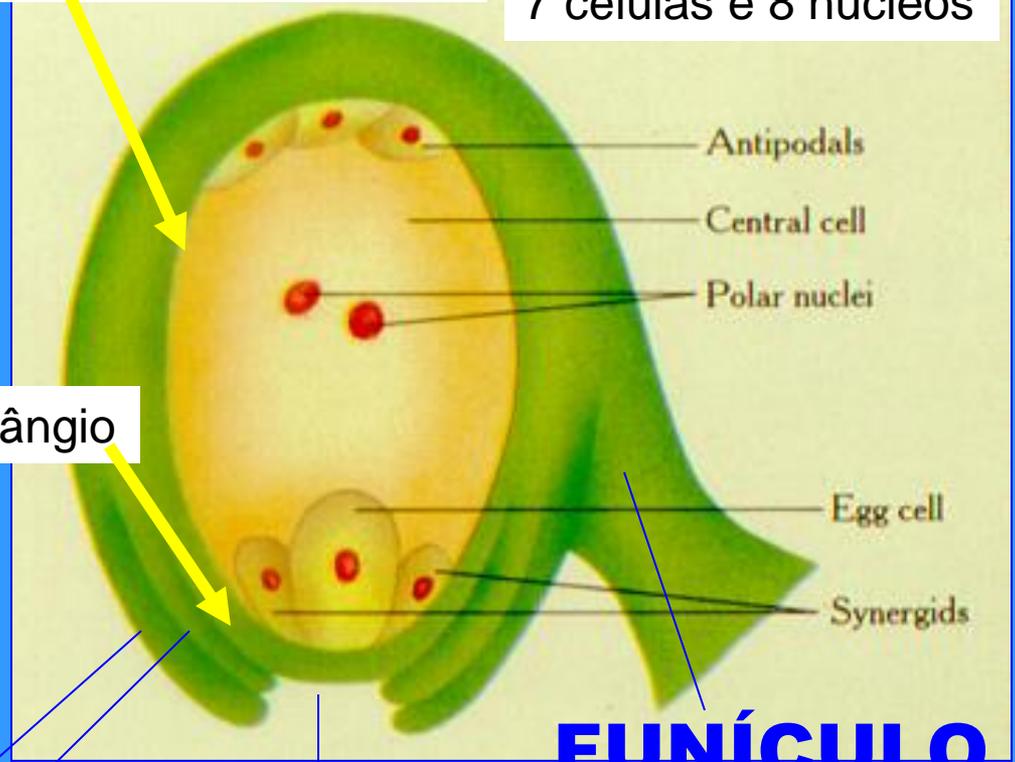
Óvulo



Gametófito feminino

reduzido a apenas 7 células e 8 núcleos

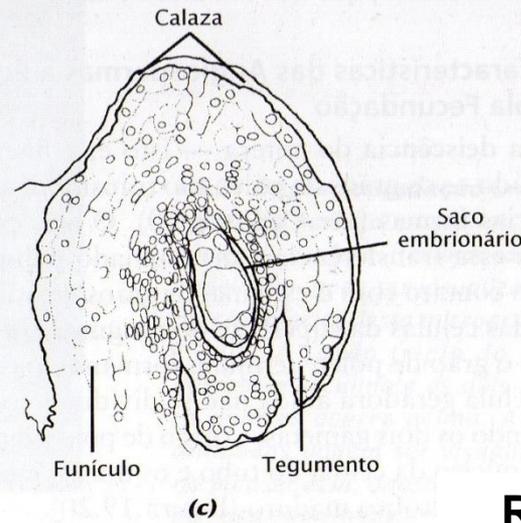
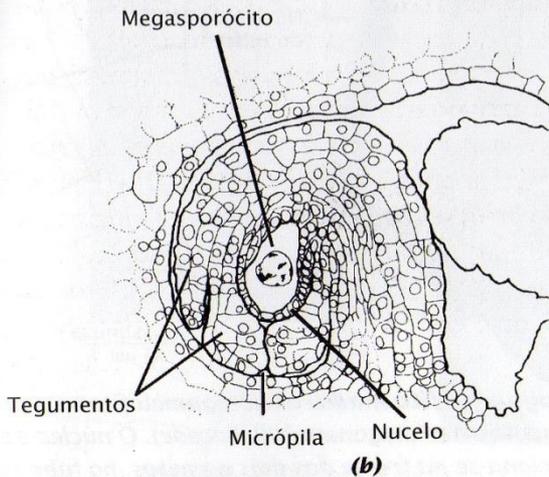
megasporângio



2 TEGUMENTOS

MICRÓPILA

FUNÍCULO



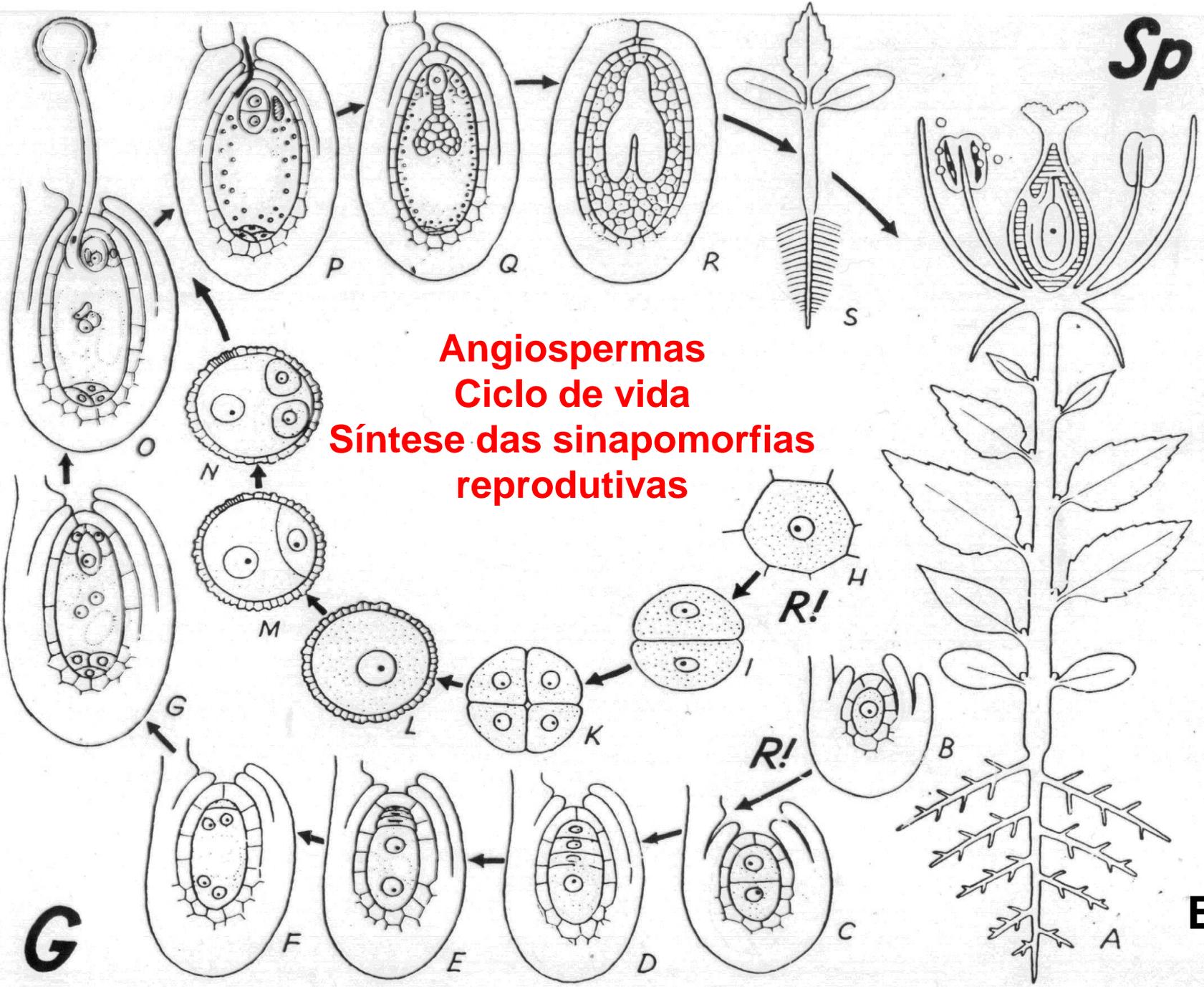
**Gametófito
feminino**

***Lilium*
Liliaceae**

Raven et al. 2007

FECUNDAÇÃO do óvulo promove:

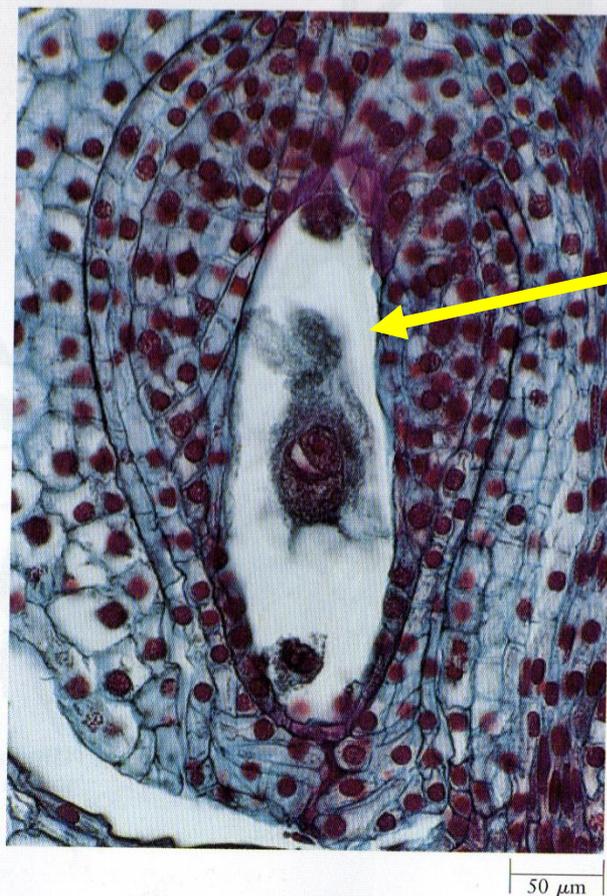
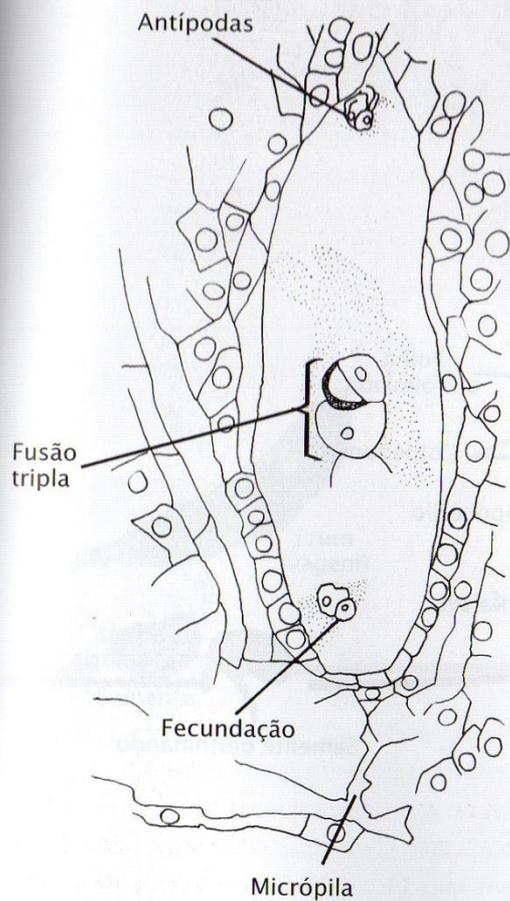
- Formação da **semente** com embrião e tecido nutritivo
- Formação do **fruto**



Angiospermas
Ciclo de vida
Síntese das sinapomorfias
reprodutivas

Engler
1964

Dupla fecundação



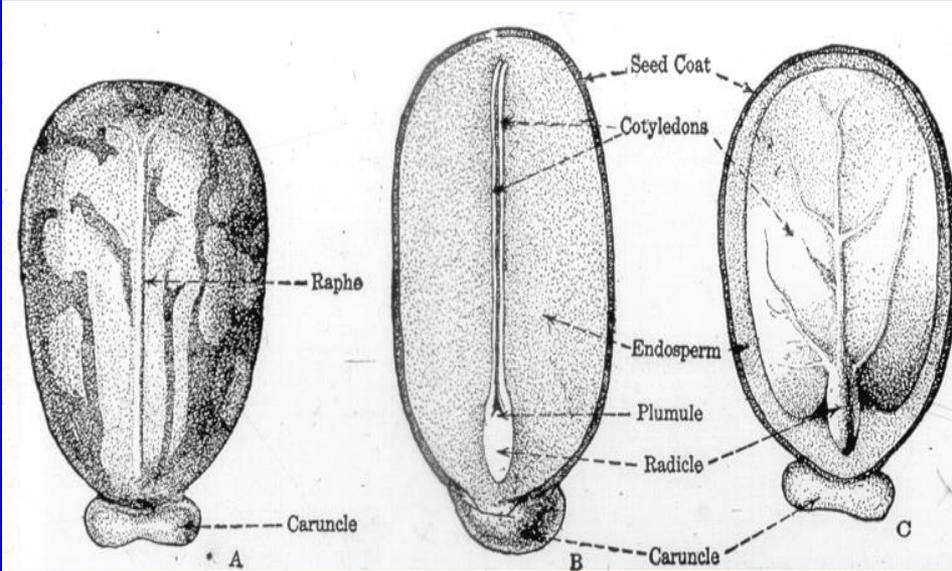
Gametófito
feminino

19.21 Dupla fecundação União do núcleo do gameta masculino com o núcleo da oosfera – fecundação “verdadeira” — pode ser visualizada na porção inferior desta micrografia de *Lilium*. A fusão tripla do outro gameta masculino e os dois núcleos polares ocorre acima. As três antípodas podem ser visualizadas no pólo calazal, oposto à micrópila do saco embrionário.

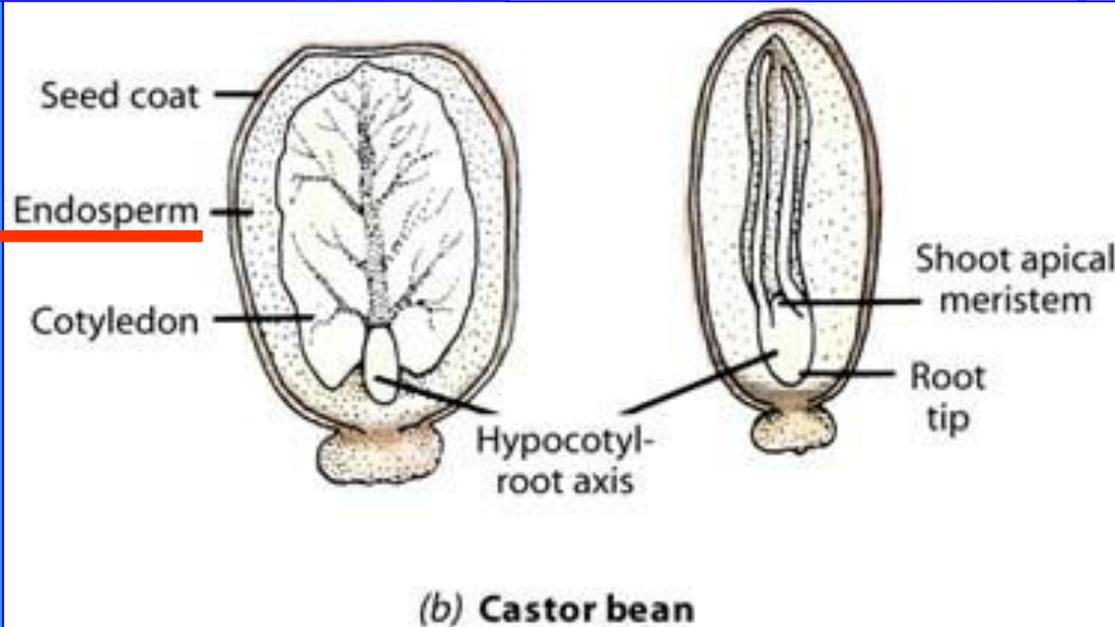
Lilium
Liliaceae

Raven et al. 2007

Endosperma na semente

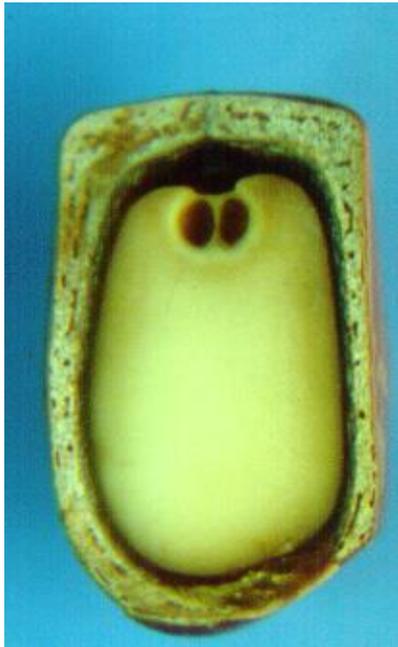


“Mamona”
Ricinus
Euphorbiaceae

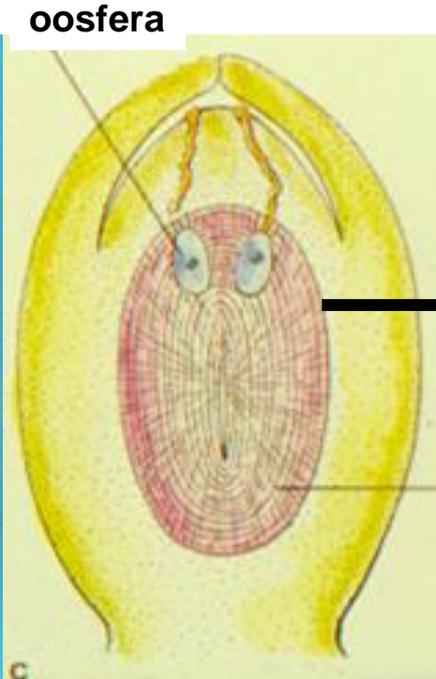


(b) Castor bean

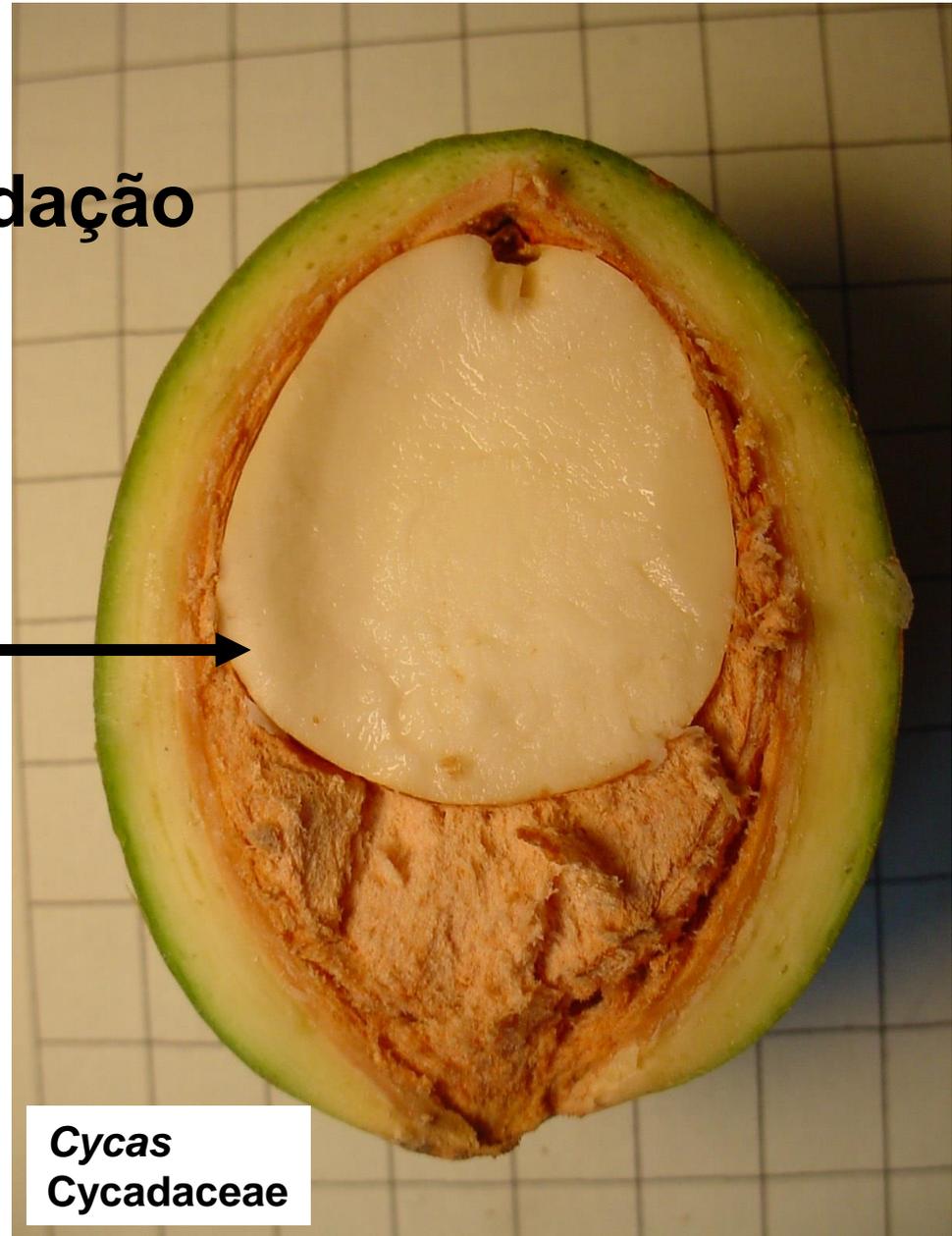
Tecido de reserva na semente das “gimnospermas: Gametófito feminino - multicelular, formado antes da fecundação



Encephalartos
Zamiaceae



CICADÓFITAS



Cycas
Cycadaceae

FRUTO = ovário maduro após fecundação dos óvulos



sépalas



estilete

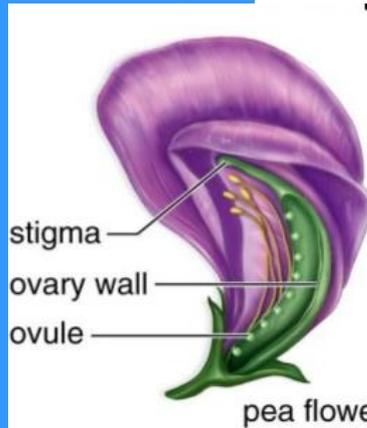
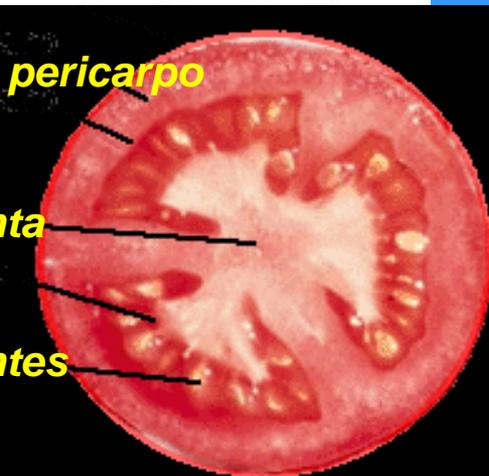
Figure 68a Immature tomato fruit, a berry (live, 1X). (Photo by J. W. Perry)

**Solanum
esculetum
tomate**

pericarpo

placenta

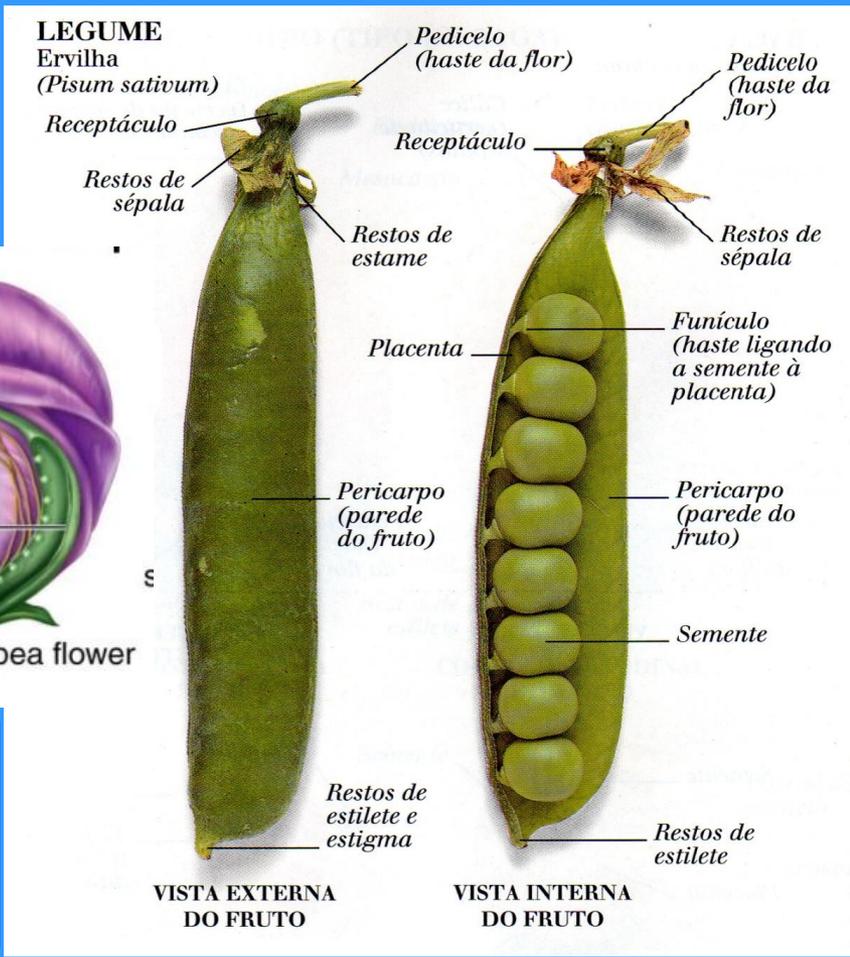
sementes



pea flower

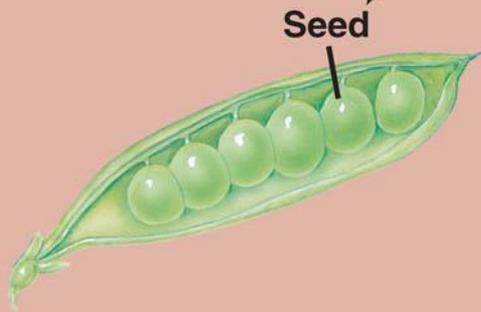
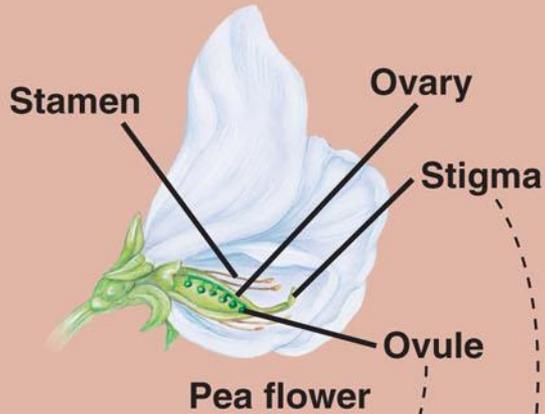
**Pisum
Sativum**

ervilha



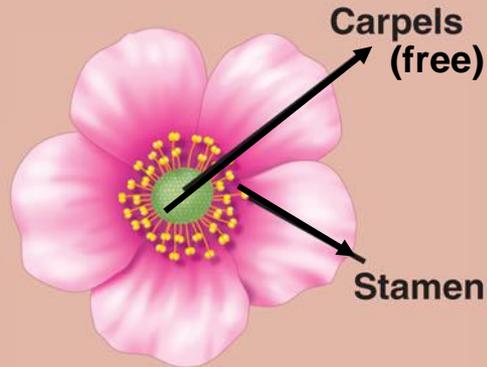
Perry & Morton 1996

Tipos de FRUTO: simples x agregado

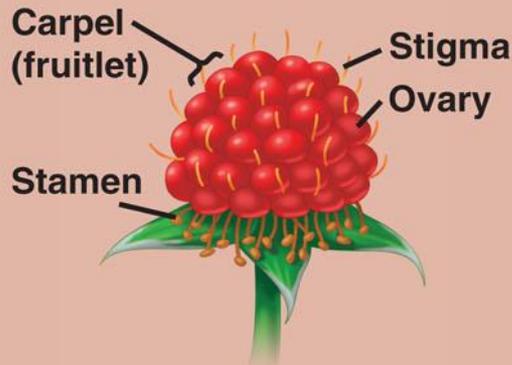


(a) Simple fruit

Fruto simples:
Derivado do ovário de uma flor



Raspberry flower



Raspberry fruit

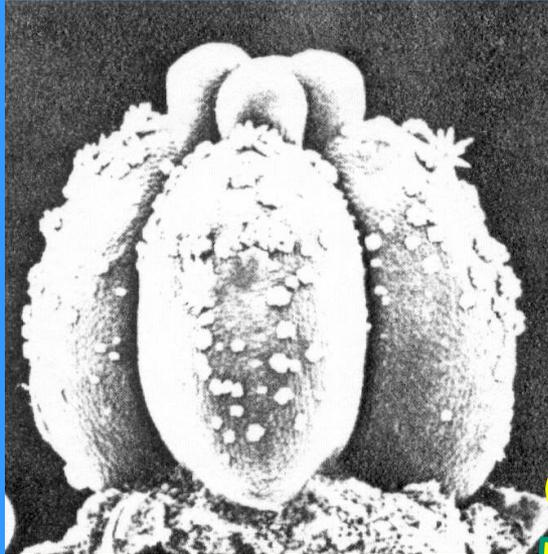
(b) Aggregate fruit

Fruto agregado:
Derivado de vários ovários de uma flor



MALVACEAE

Fruto agregado



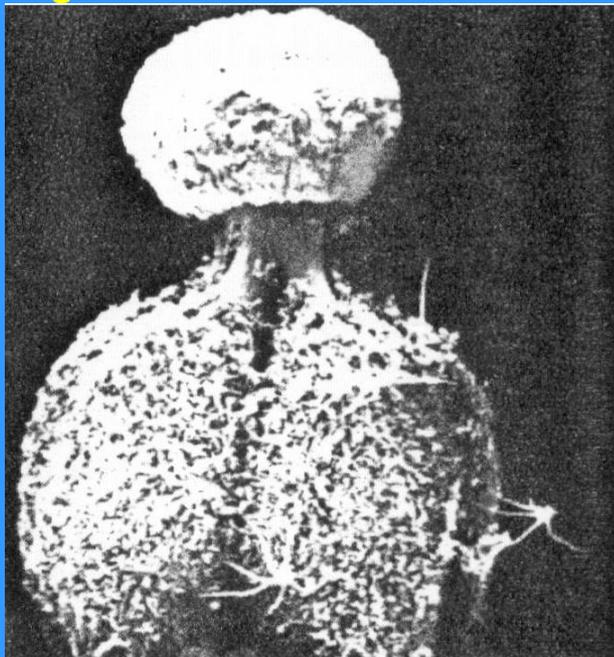
Gineceu



Sterculia ceramica

fruto com 4 frutículos livres

Weberling
1998



Brachychiton

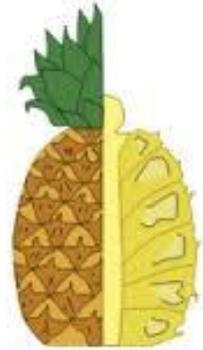


Chichá
Sterculia chicha

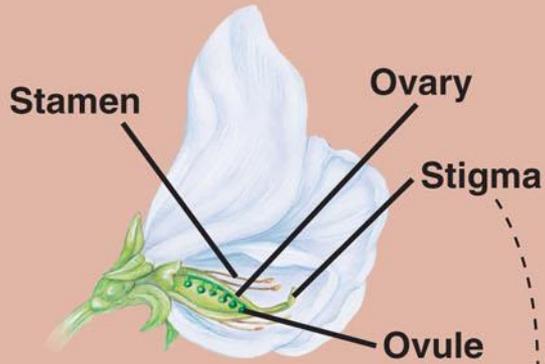
Sterculia curiosa



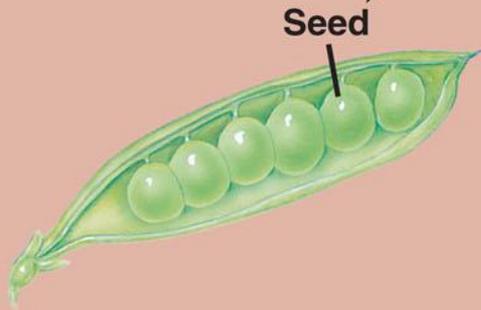
Fruto múltiplo:
União de ovários de várias flores.
Ex. Abacaxi (*Ananas comosus*, Bromeliaceae) - flores densamente reunidas numa inflorescência originam a infrutescência



Tipos de FRUTO: simples x agregado x múltiplo



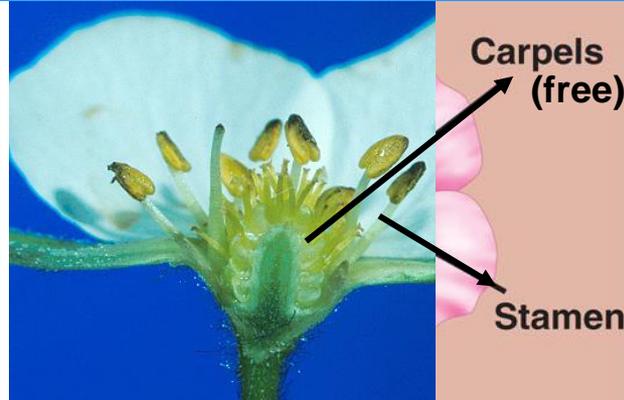
Pea flower



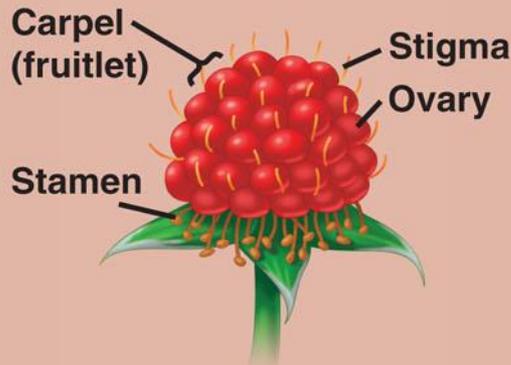
Pea fruit

(a) Simple fruit

Fruto simples:
Derivado do ovário de uma flor



Raspberry flower



Raspberry fruit

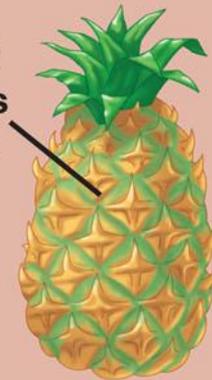
(b) Aggregate fruit

Fruto agregado:
Derivado de vários ovários de uma flor



Pineapple inflorescence

Each segment develops from the carpel of one flower



Pineapple fruit

(c) Multiple fruit

Fruto múltiplo:
Derivado da união de ovários de várias flores

FRUTOS:

Diversidade morfológica e múltiplas formas de dispersão

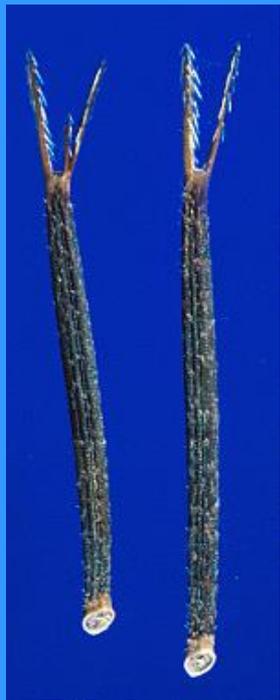


DISPERSÃO

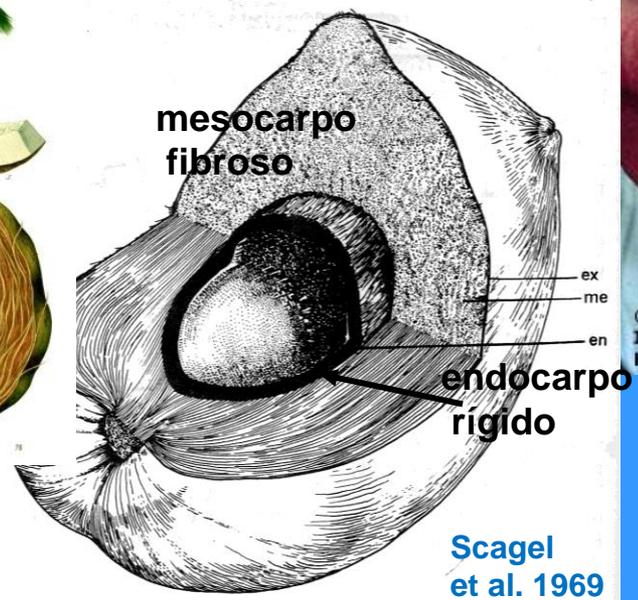
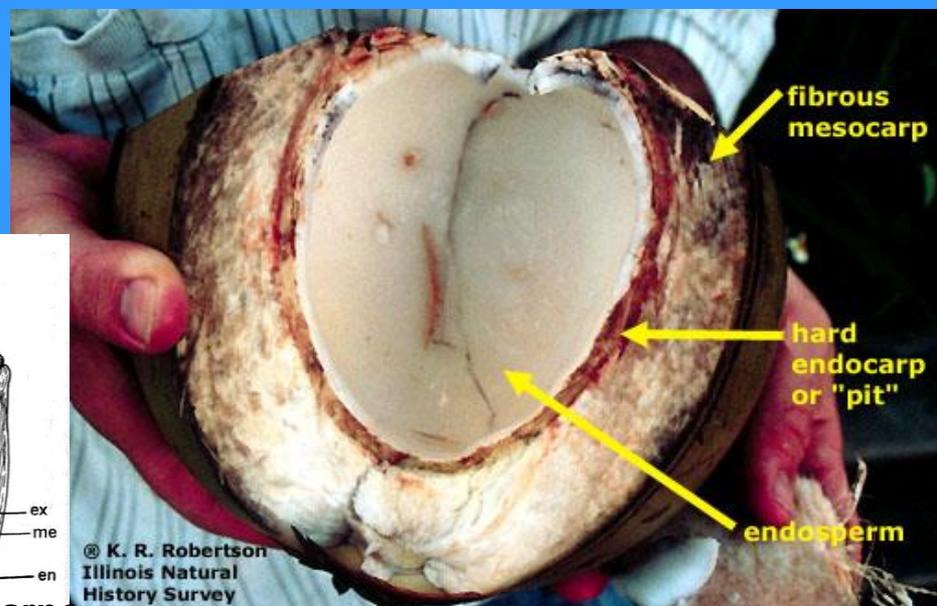
BIÓTICA
zoocoria



ABIÓTICA



FRUTO *Cocos nucifera*



© K. R. Robertson
Illinois Natural
History Survey

Scagel
et al. 1969

Brown 1963

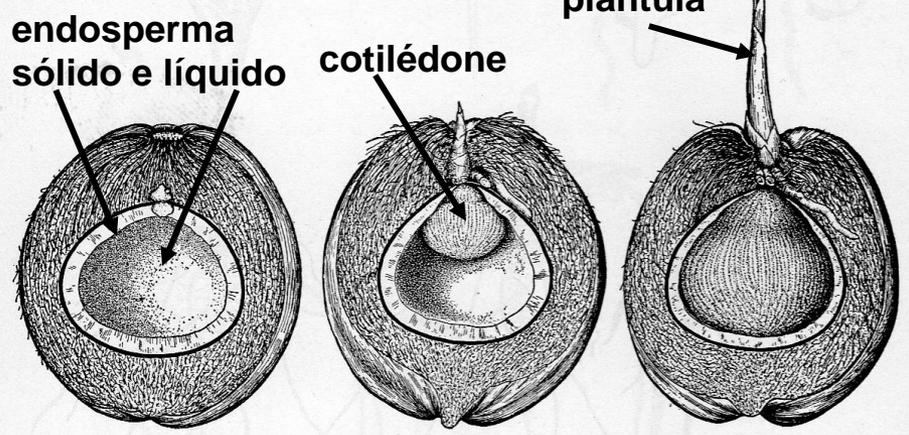
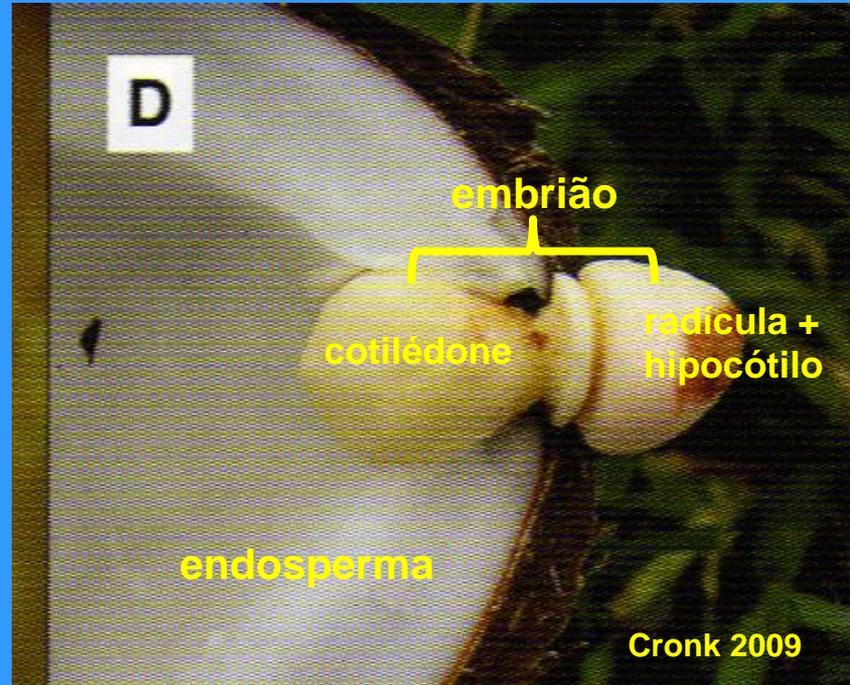


FIG. 389. Successive stages in the germination of coconut



Cronk 2009

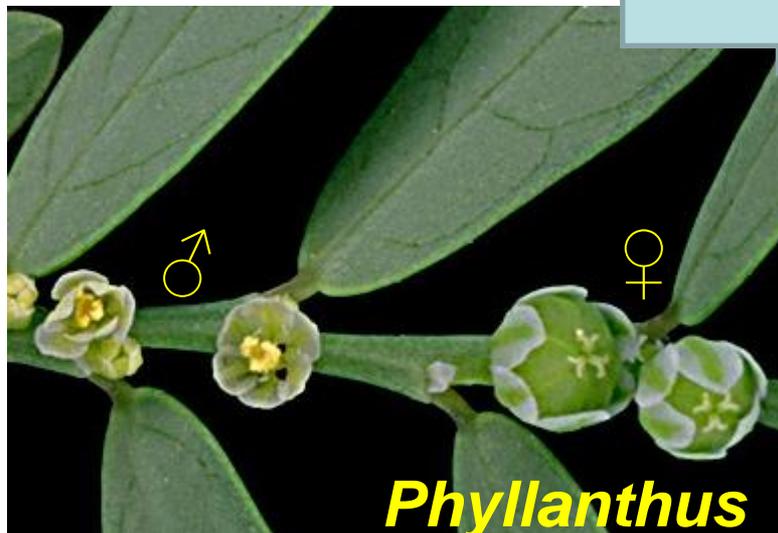
(*Cocos nucifera*) showing germination. The transfer cotyledon (section 5.20) embedded in the coconut flesh (endosperm). Emerging from the "eye" is a structure comprising the radicle, hypocotyl and cotyledonary petiole. The plumule is encased in the tubular cotyledonary petiole, from which it will later break out.

Flores e sexualidade

Maioria das flores é bissexuada (70 % das spp atuais)



Flores unissexuadas



PHYLLANTHACEAE

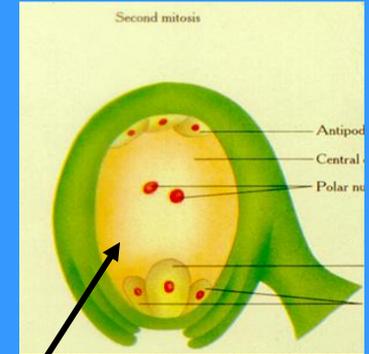
Exemplos: EUPHORBIACEAE,

SÍNTESE

Novidades evolutivas reprodutivas das angiospermas

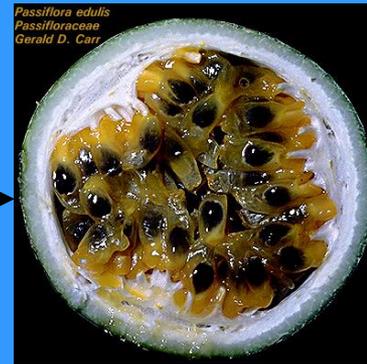


Flor com partes verticiladas (grande maioria) e variados graus de união entre as partes



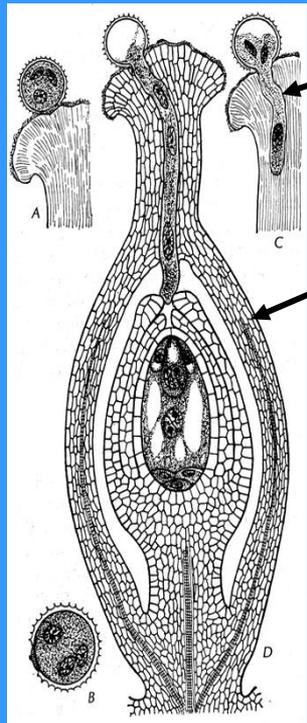
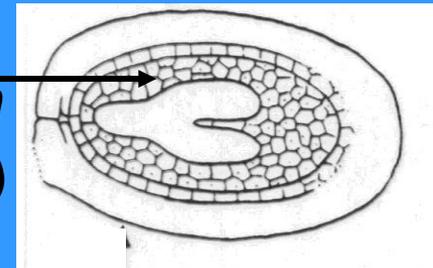
Redução dos gametófitos a poucas células (tubo polínico com apenas 3 células; megagametófito com apenas 7 células)

Óvulos envolvidos pelo(s) carpelo(s) = semente(s) no fruto



Polinização e fecundação rápidas e com diversos vetores abióticos e bióticos

Dupla-fecundação – Endosperma $3n$ (raramente $2n$)



Diversidade relativa das Embriófitas

Crepet & Niklas
2009

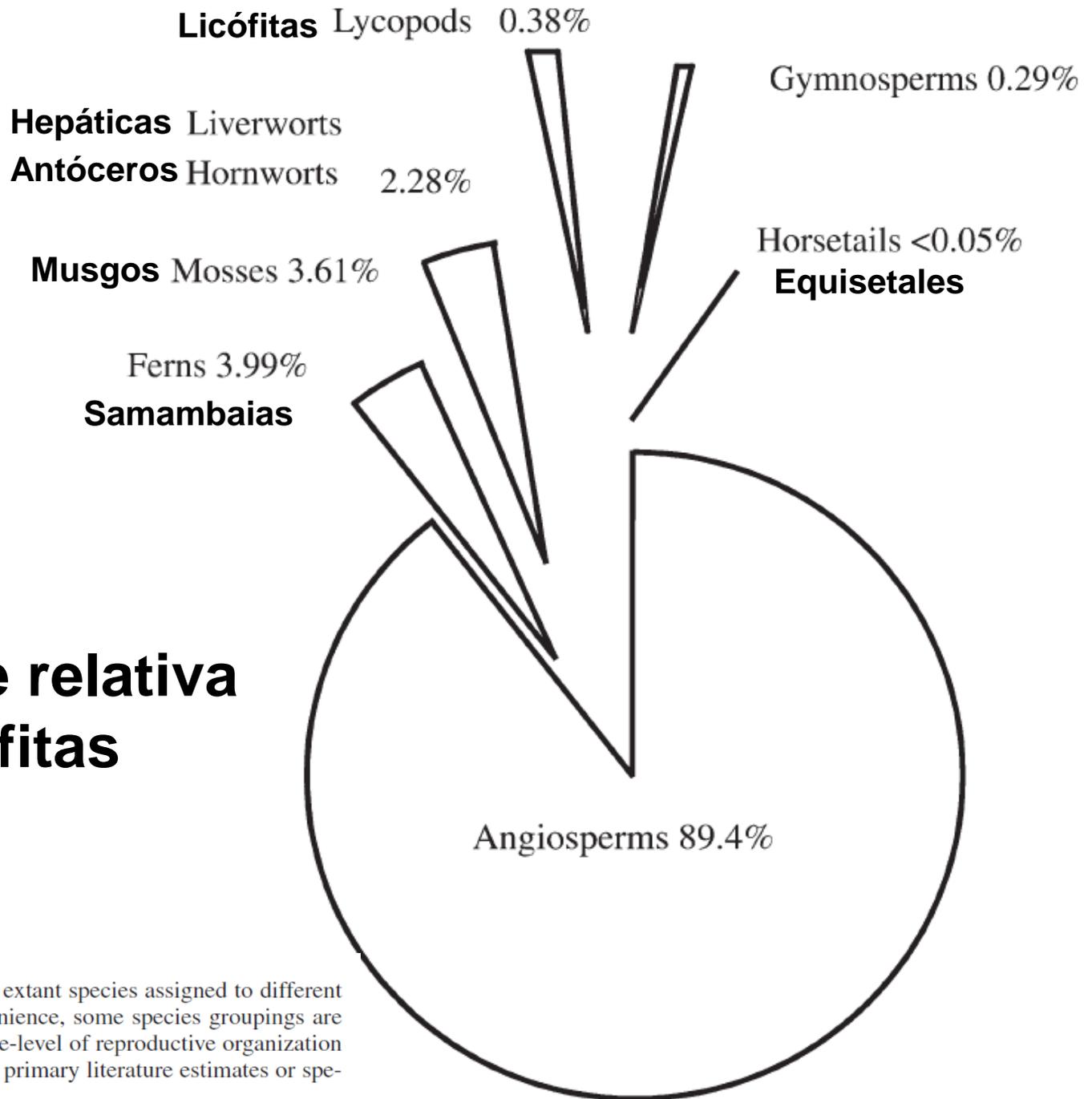


Fig. 1. Percentage distribution of extant species assigned to different embryophyte plant groups. For convenience, some species groupings are polyphyletic and thus represent a grade-level of reproductive organization (e.g., gymnosperms). Data taken from primary literature estimates or species compendia (see Niklas, 1997).

Novidades evolutivas reprodutivas das angiospermas seriam inovações-chave?

