



Carpinus, Ostrya, Ostryopsis and their friends...



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Engler (end 19th century) : “Amentiferae”

Amentiferae

APG II 2003

Betulaceae

Fagales

Casuarinaceae

Fagales

Fagaceae

Fagales

Juglandaceae

Fagales

Myricaceae

Fagales

Ulmaceae

Rosales

Moraceae

Rosales

Urticaceae

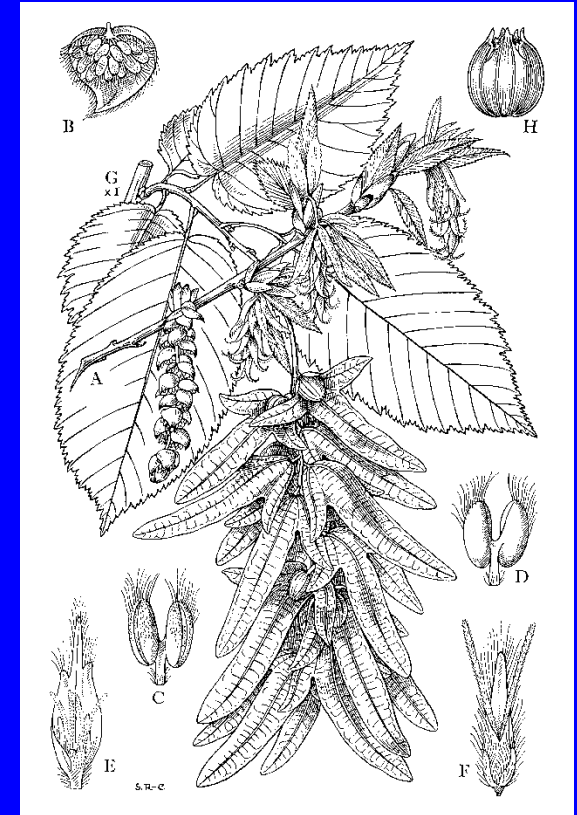
Rosales

Salicaceae

Malpighiales

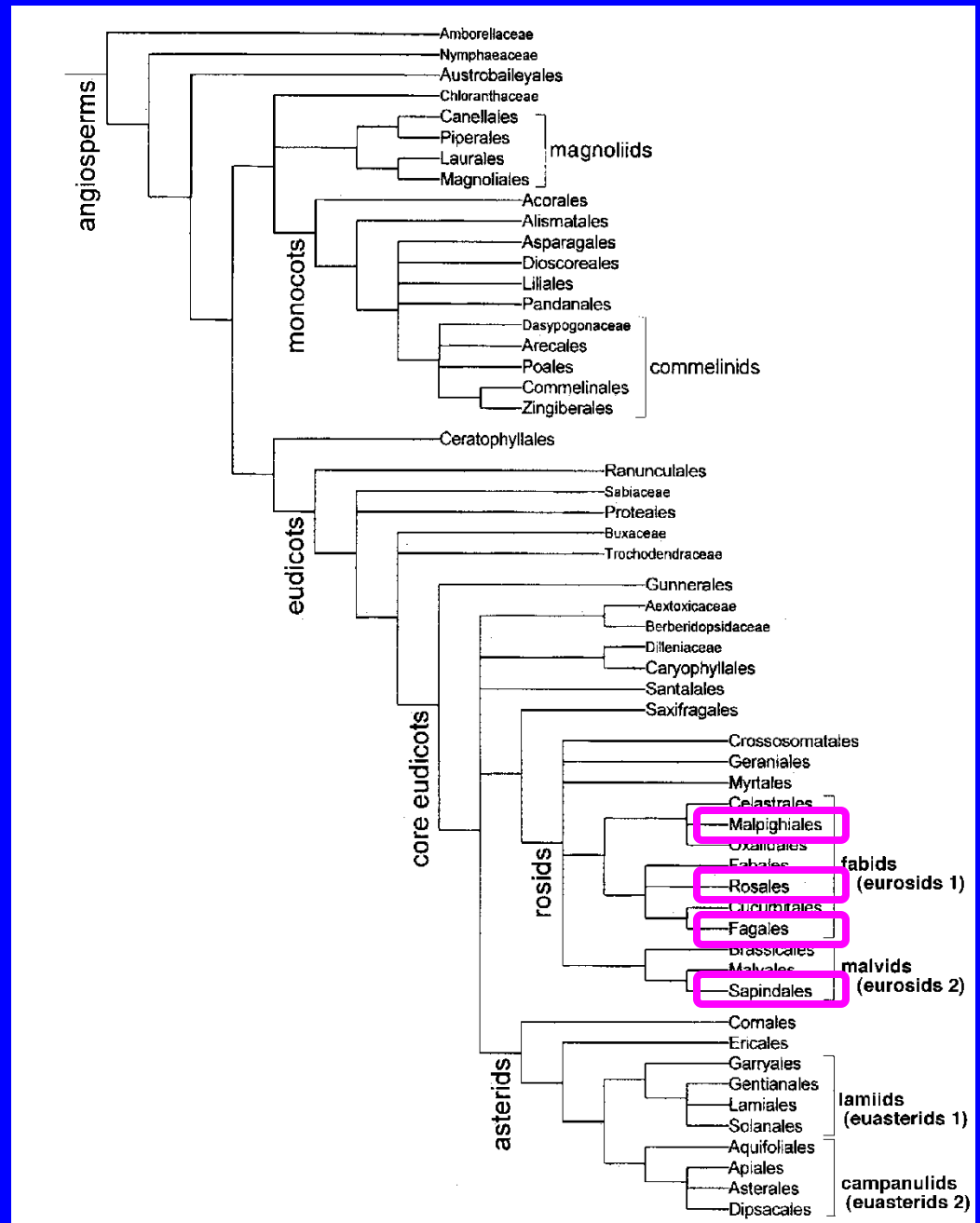
Leitneriaceae

Sapindales



(Ross-Craig 1979)

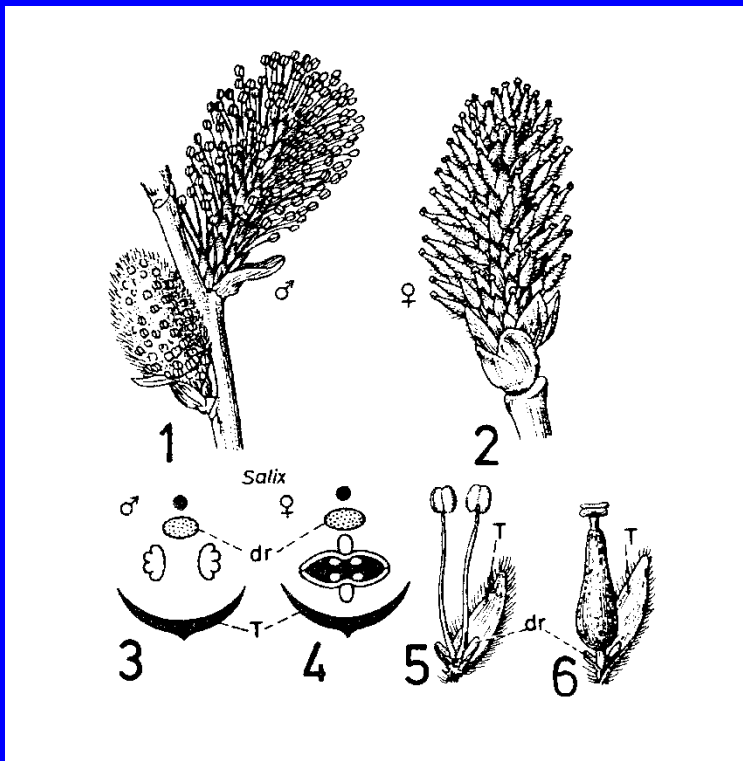
**“Amentiferae”
in
APG II 2003 ?**



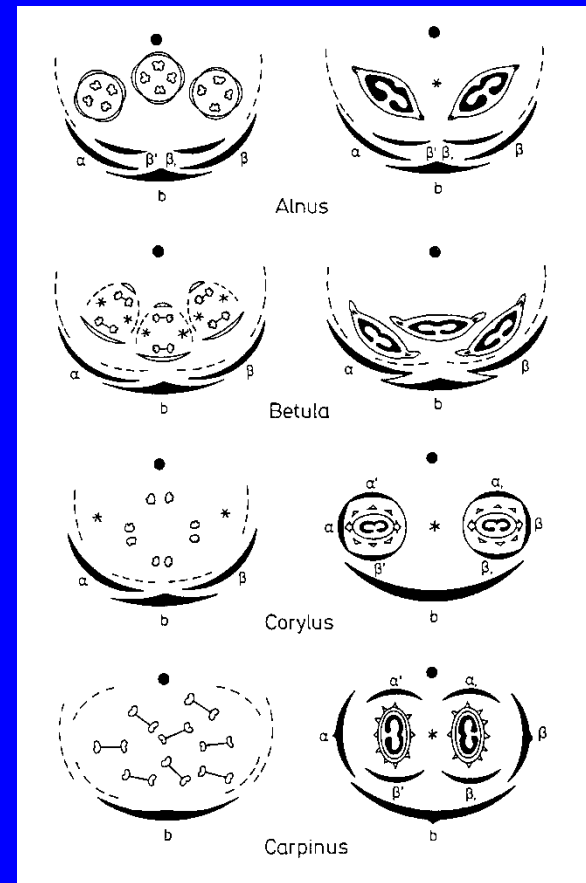
“Amentum” = catkin

“true” catkin

“false” catkin



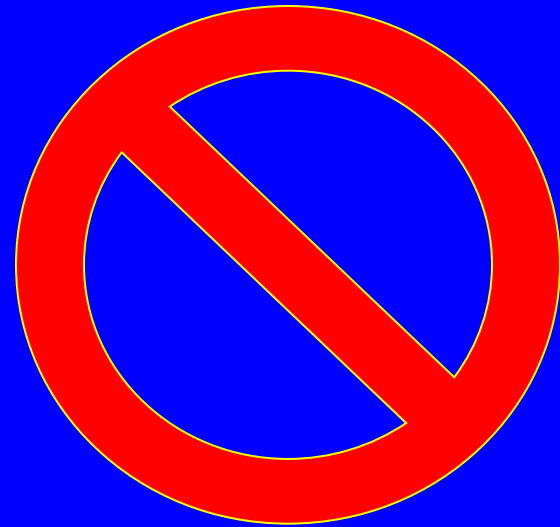
(Graf 1975)



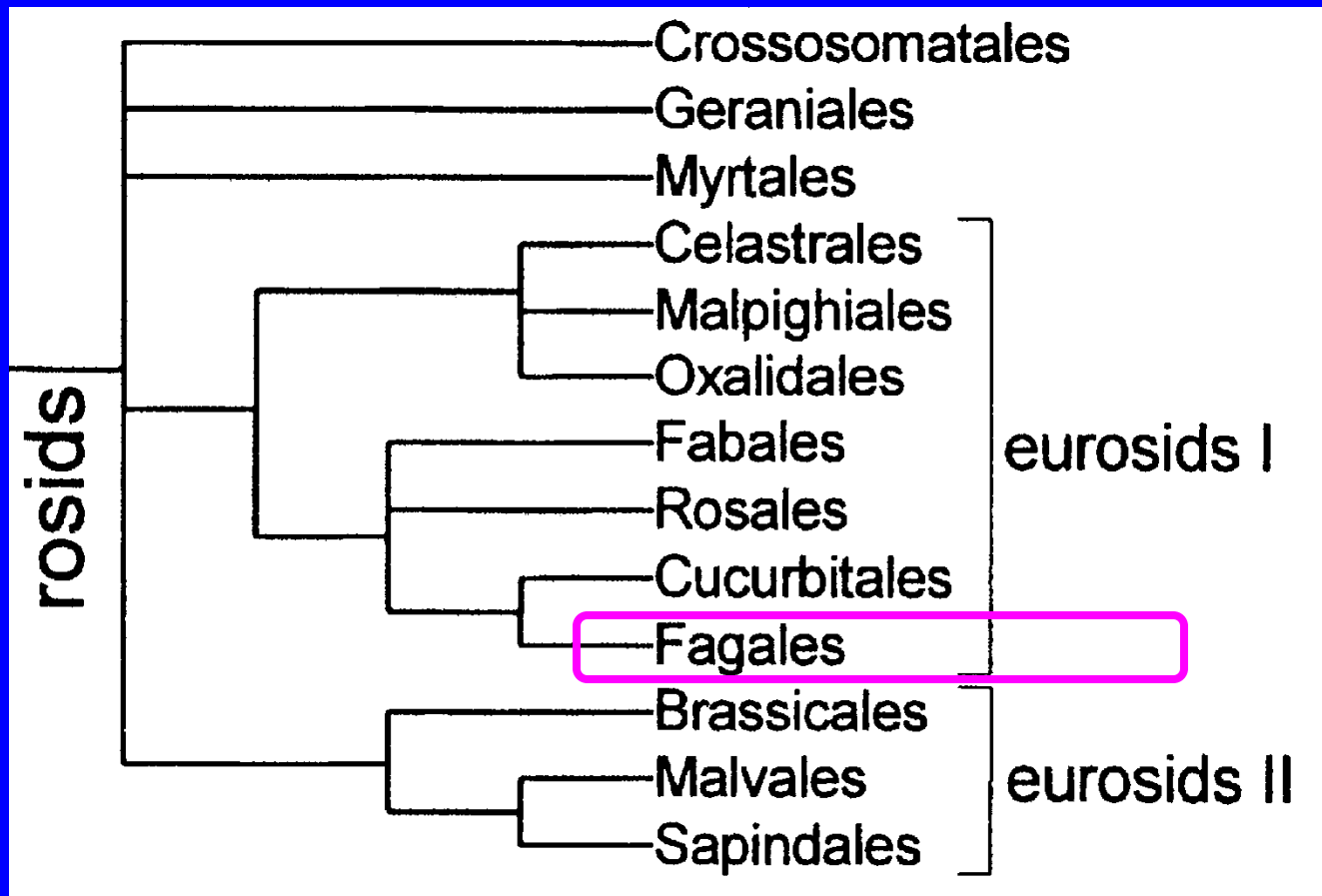
(Kubitzki 1993)

Anemophily

*anemophily is here a
NEW character state,
DERIVED from
entomophilous ancestors*



***Anemophily in Fagales =
derived from entomophilous ancestors***



(APG II 2003)

Phylogenetic position in APG II 2003 ?

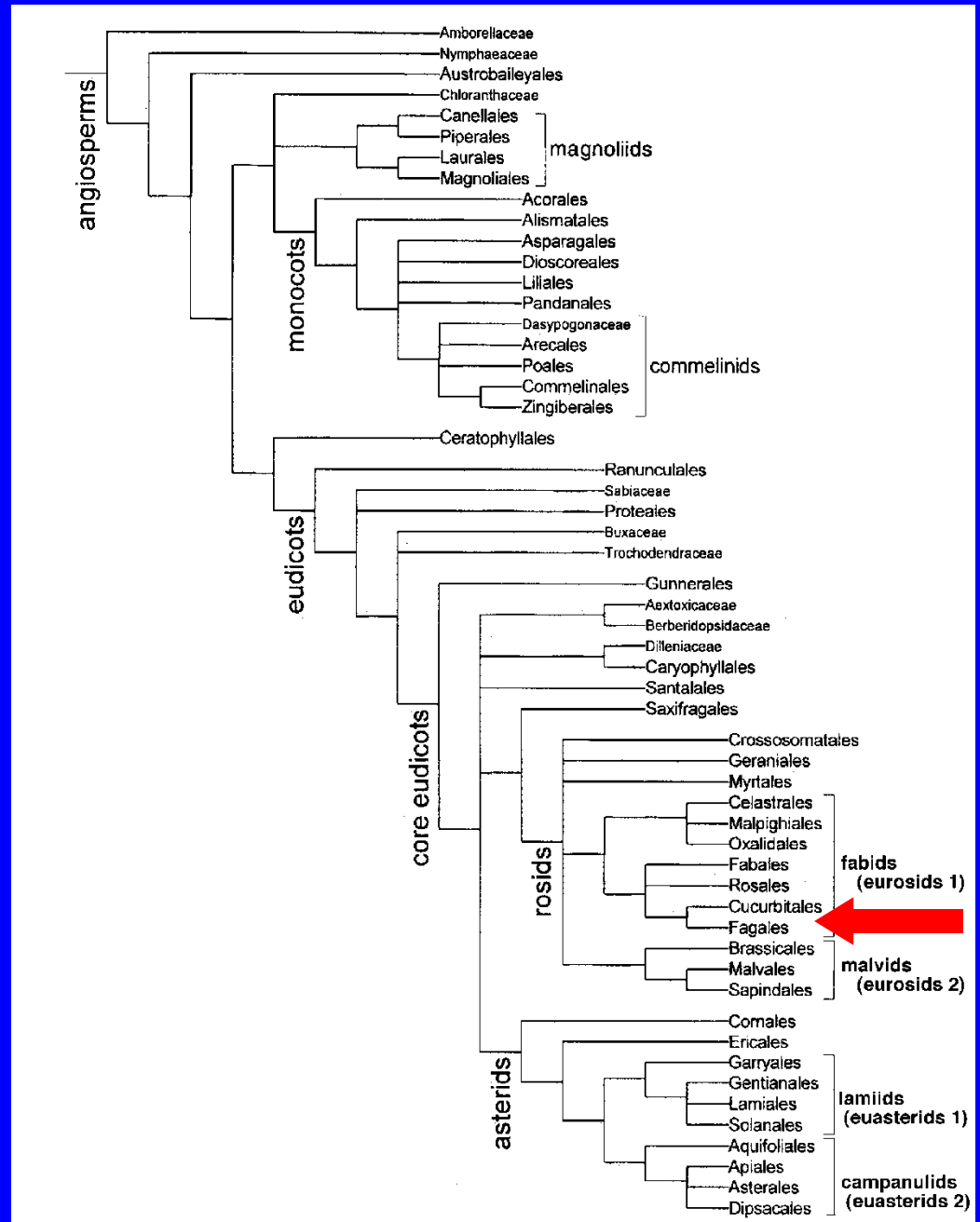
eudicots

core eudicots

rosids

fabids

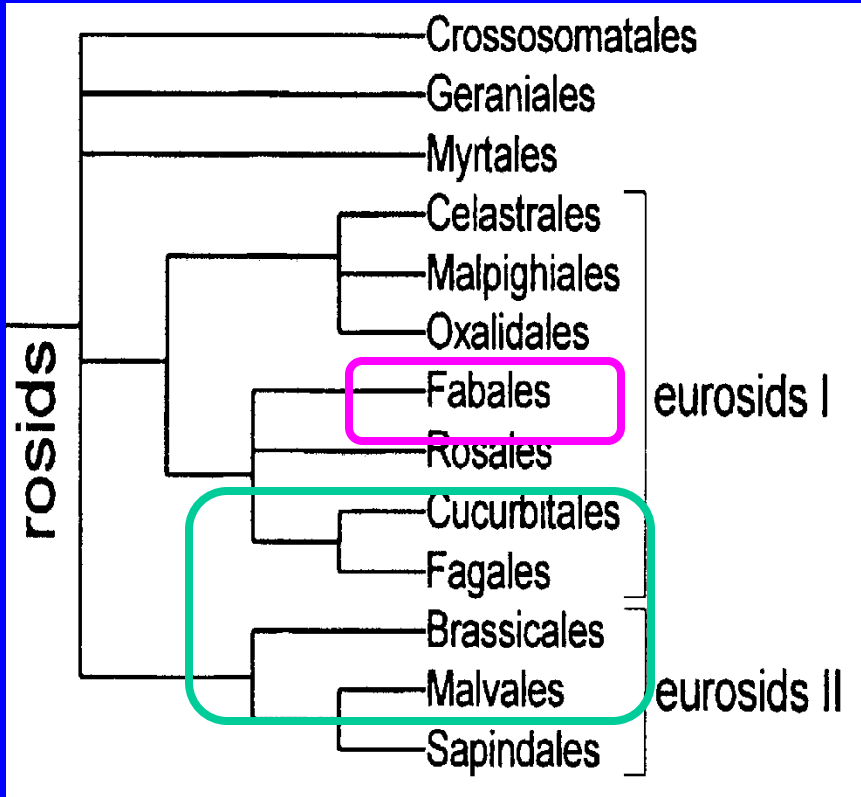
Fagales



Rosids (APG II 2003) :

Rhizobium

Frankia



Frankia nodules on *Alnus*

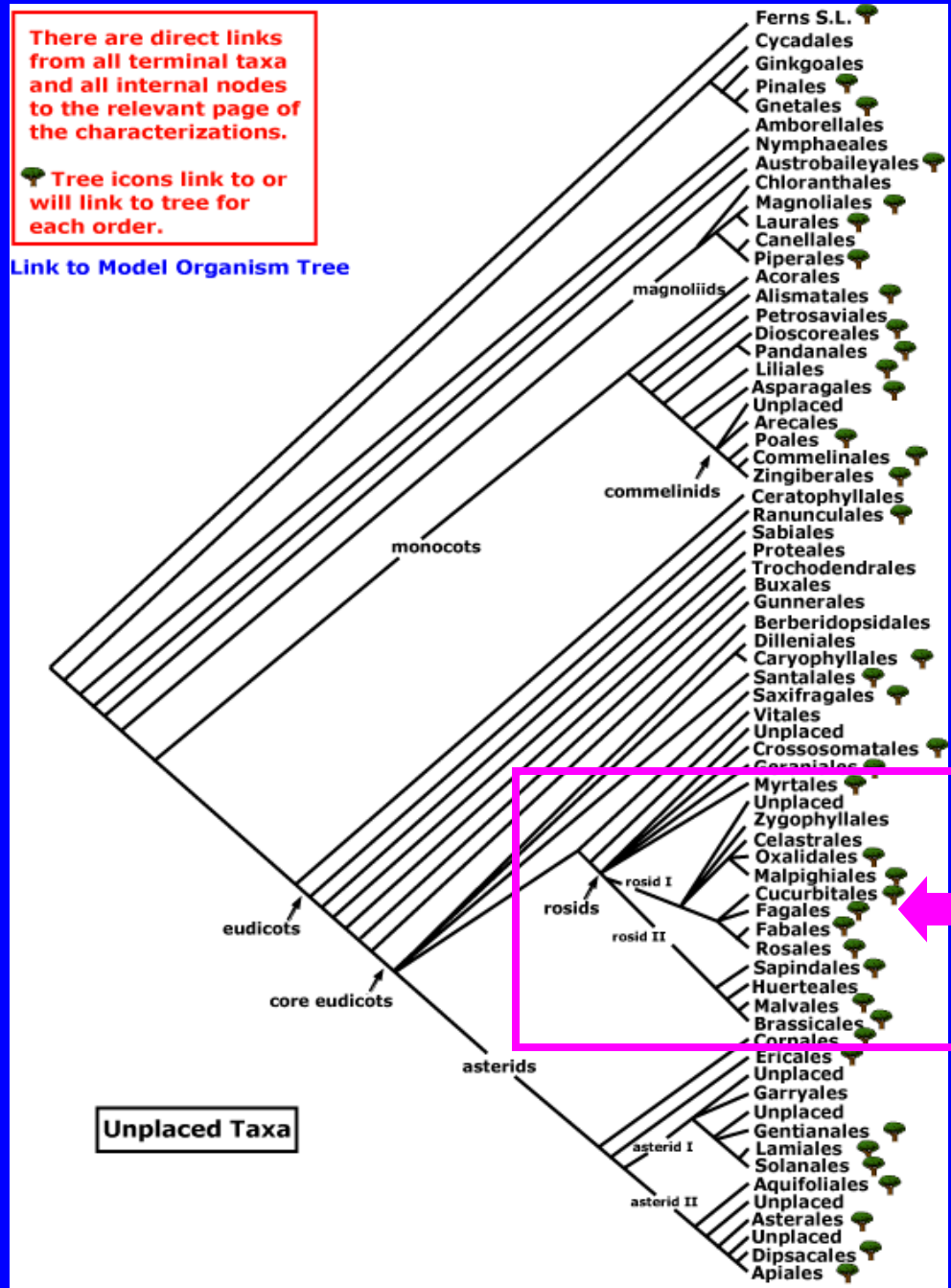
**Adapted
classification
of
APG II 2003**

Rosids

Fabids

Fagales

(APWeb 2009)

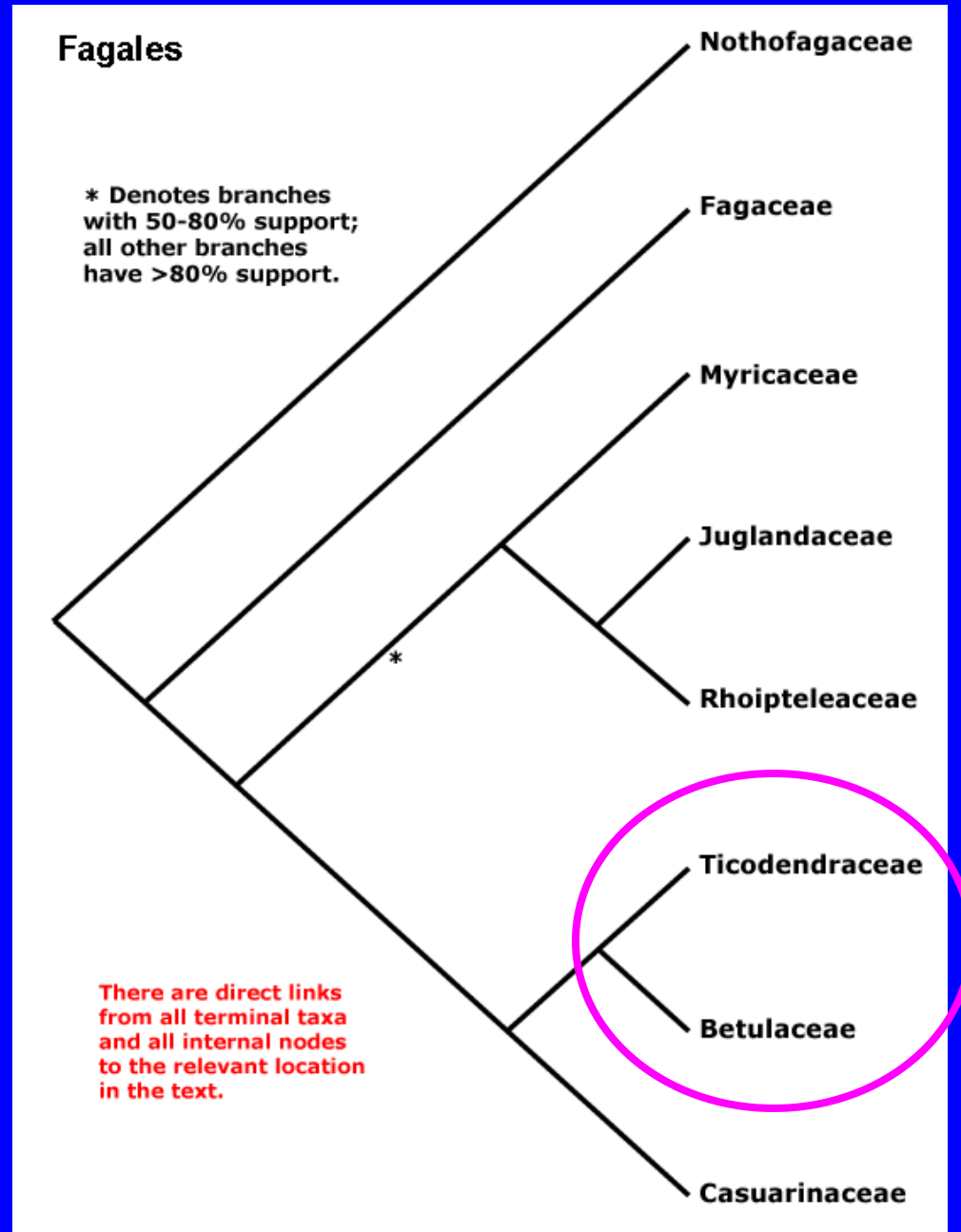


Fagales : 8 families

*Betulaceae
and
Ticodendraceae*

: sister groups

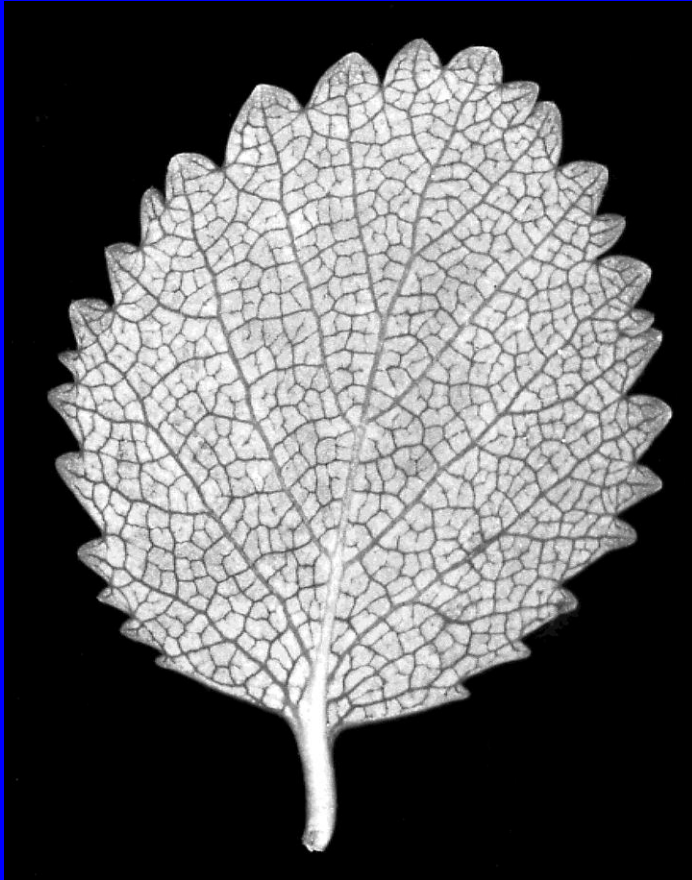
(APWeb 2009)



***Ticodendron incognitum* : primary craspedodromous**



Betulaceae : primary and secondary craspedodromous



Betula pumila



Betula schmidtii

***Ticodendron incognitum* : stipules large, leaving circular scar**



Betulaceae : stipules with a narrow base



Corylus avellana



Carpinus tschonoskii

Betulaceae

Vegetative morphology

Alnus : morphology of winter buds

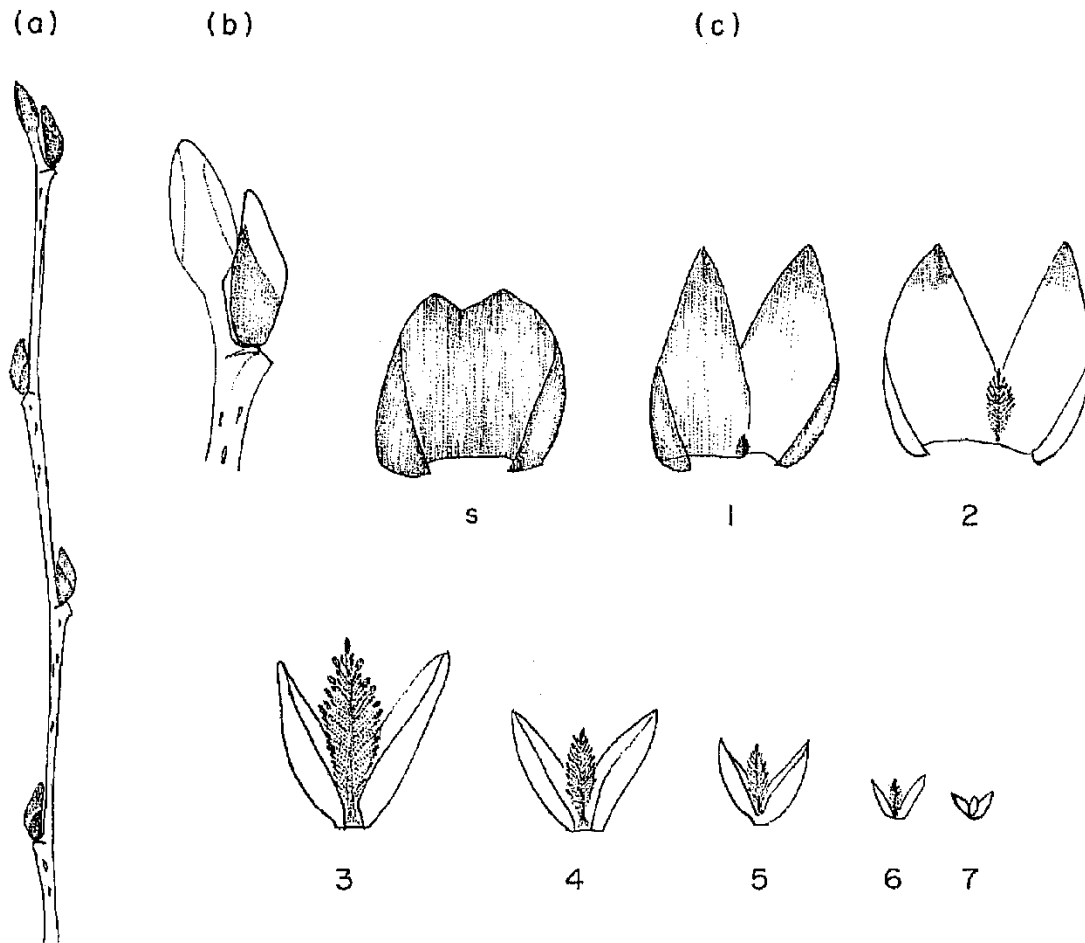


FIG. 3. Morphology and anatomy of the winter bud of *Alnus pendula*. (a) Twig. (b) Terminal and lateral bud. (c) Anatomy of the lateral bud. Numerals indicate leaf order and 's' indicates the bud scale.

***Alnus* : terminal bud & lateral buds**



Betula : morphology of winter buds

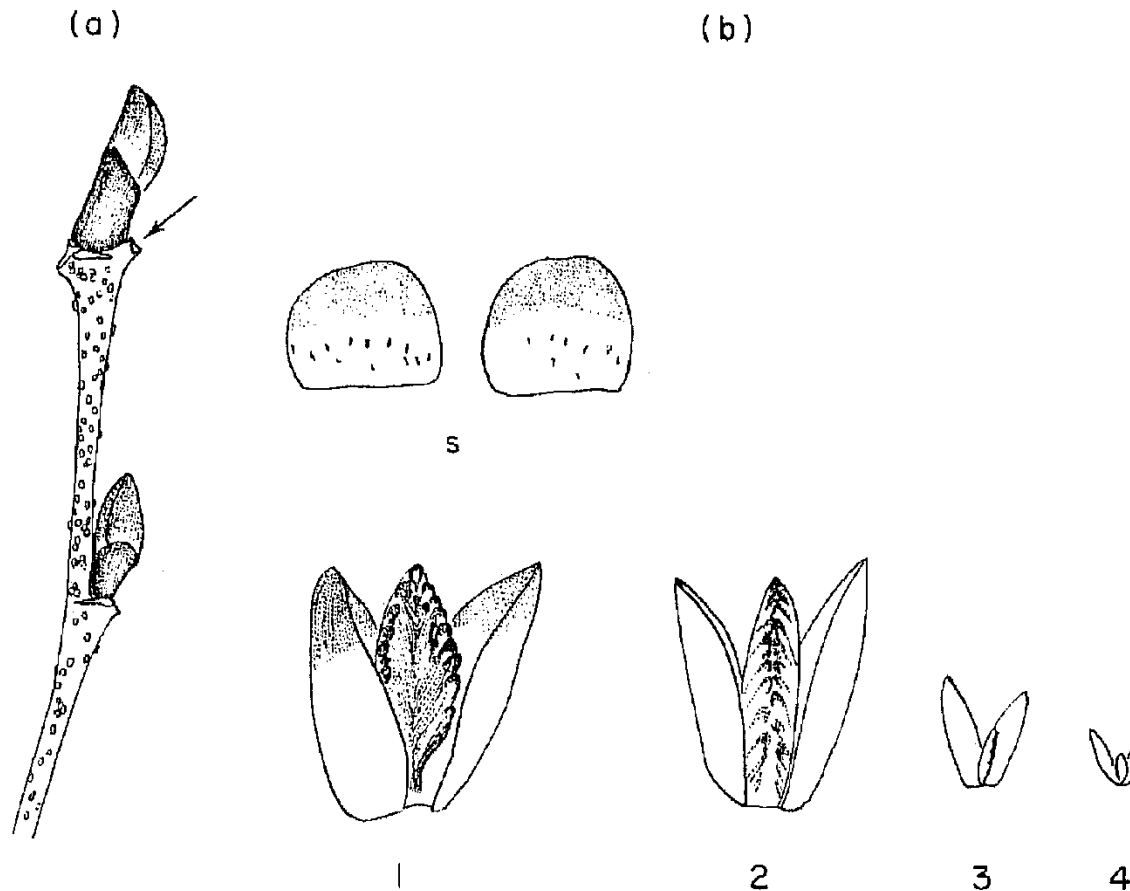


FIG. 4. Morphology and anatomy of winter bud of *Betula platyphylla* var. *japonica*. (a) Twig. An arrow indicates the shoot tip abortion. (b) Anatomy of the lateral bud. Numerals indicate leaf order and 's' indicates bud scales.

***Betula* : lateral buds & aborted shoot tip or ?**



Betula schmidtii



Betula apoiensis

Carpinus : morphology of winter buds

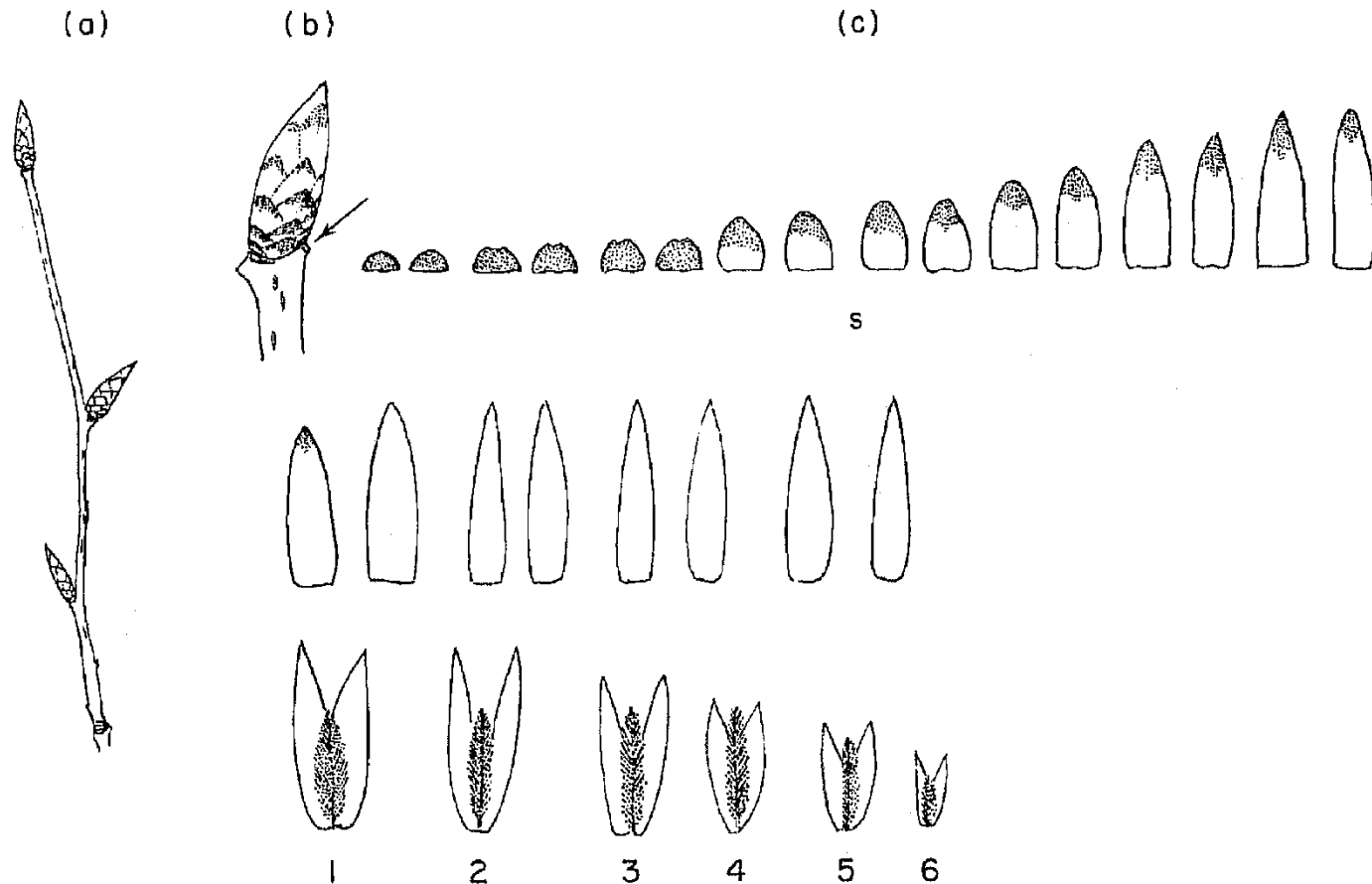


FIG. 5. Morphology and anatomy of the winter bud of *Carpinus cordata*. (a) Twig. (b) Pseudo-terminal bud. An arrow indicates shoot tip abortion. (c) Anatomy of the bud. Numerals indicate leaf order and 's' indicates bud scales.

***Carpinus* : lateral buds & aborted shoot tip**



Carpinus tschonoskii

Betulaceae : morphology of winter buds, summary

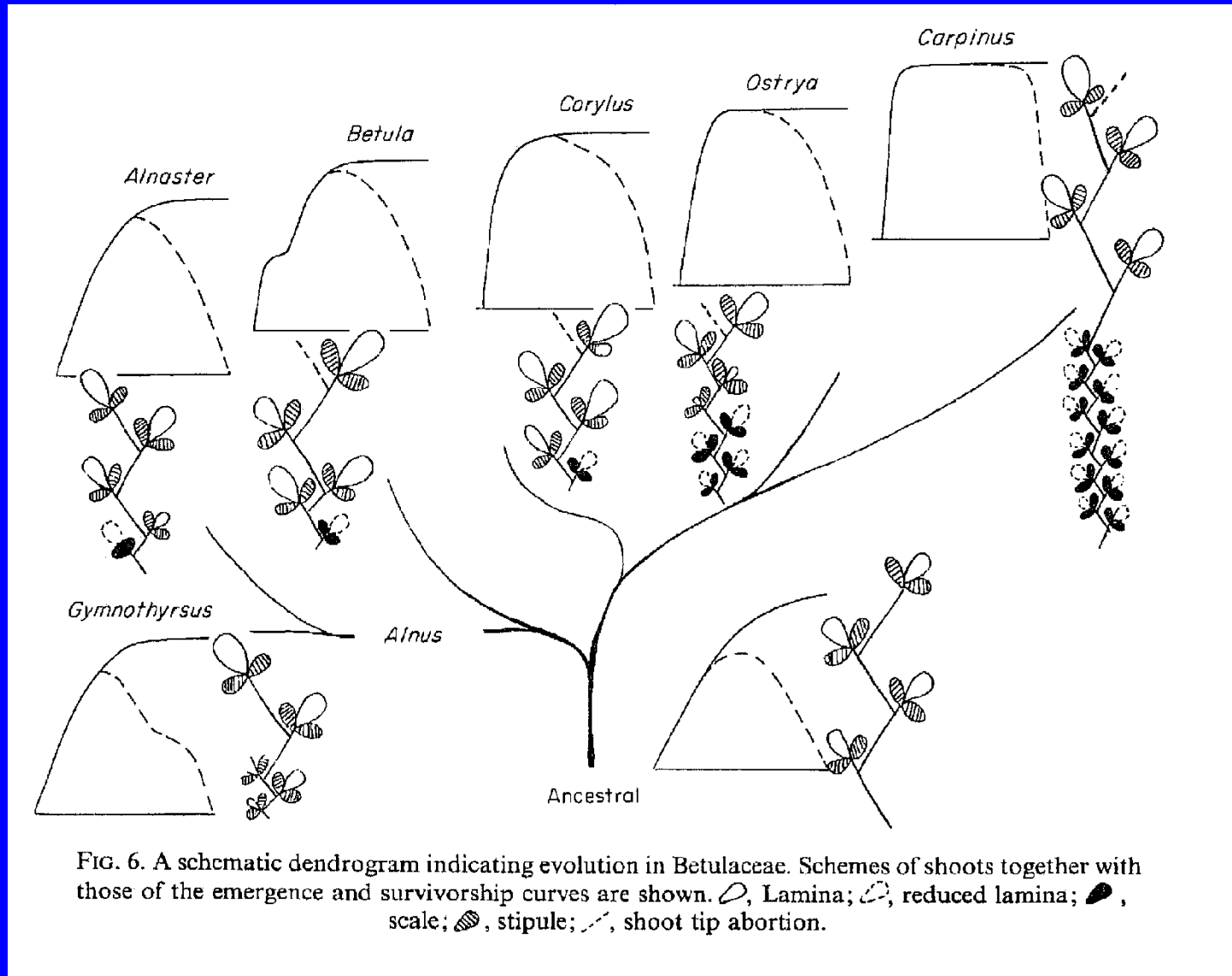


FIG. 6. A schematic dendrogram indicating evolution in Betulaceae. Schemes of shoots together with those of the emergence and survivorship curves are shown. ○, Lamina; ⊖, reduced lamina; ●, scale; ▨, stipule; - - -, shoot tip abortion.

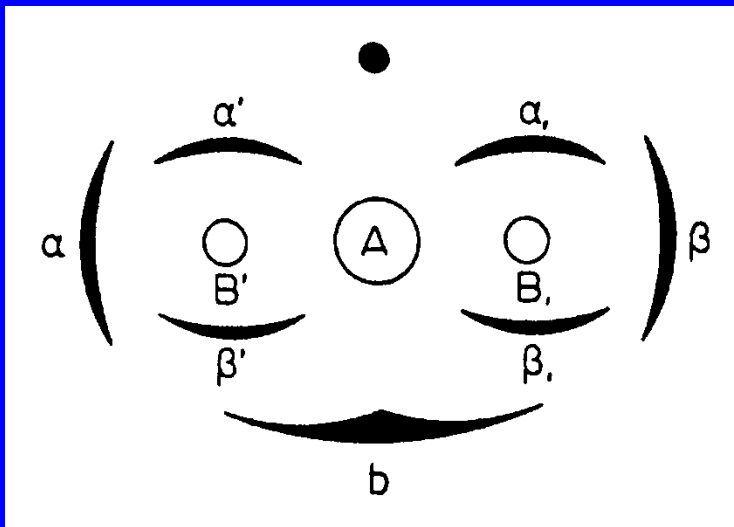
(Kikuzawa 1982)

Betulaceae

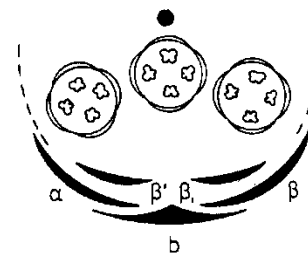
Flowering morphology

Flowering unit = cyme :

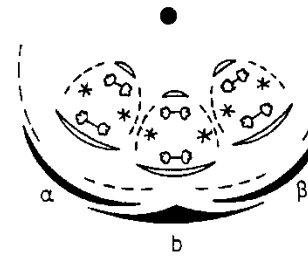
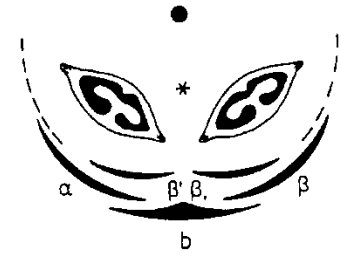
bracts & bracteoles



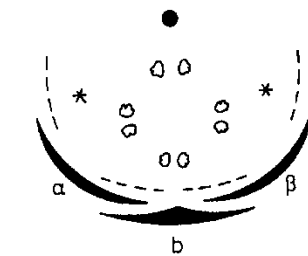
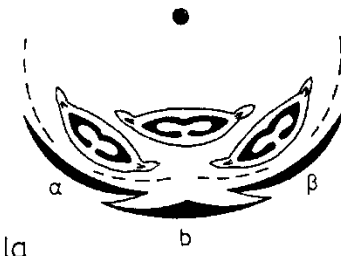
(Kubitzki 1993)



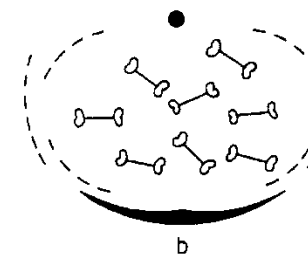
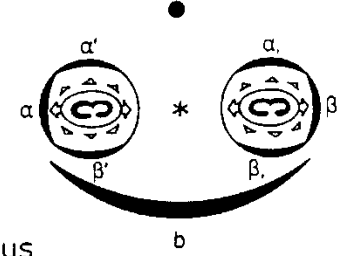
Alnus



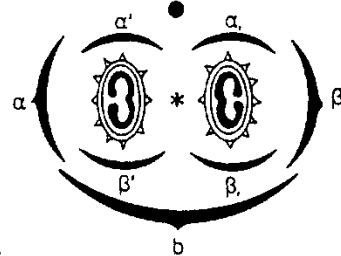
Betula



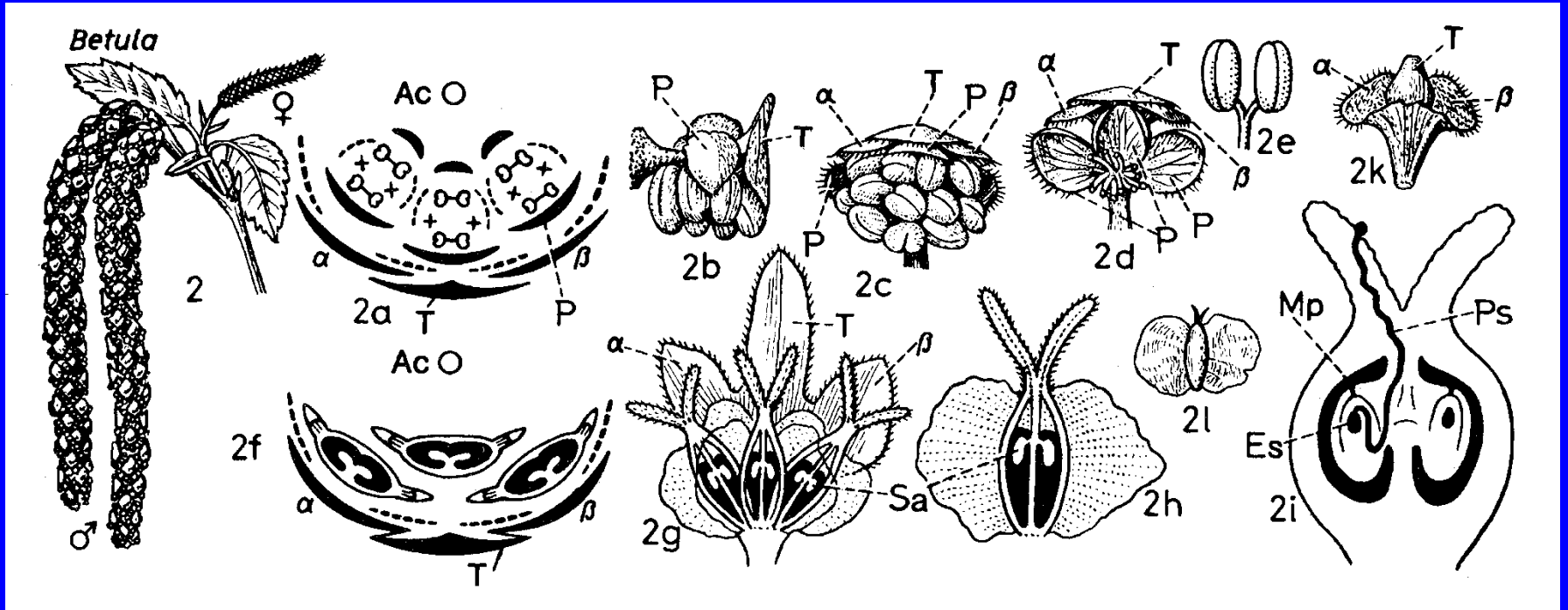
Corylus



Carpinus

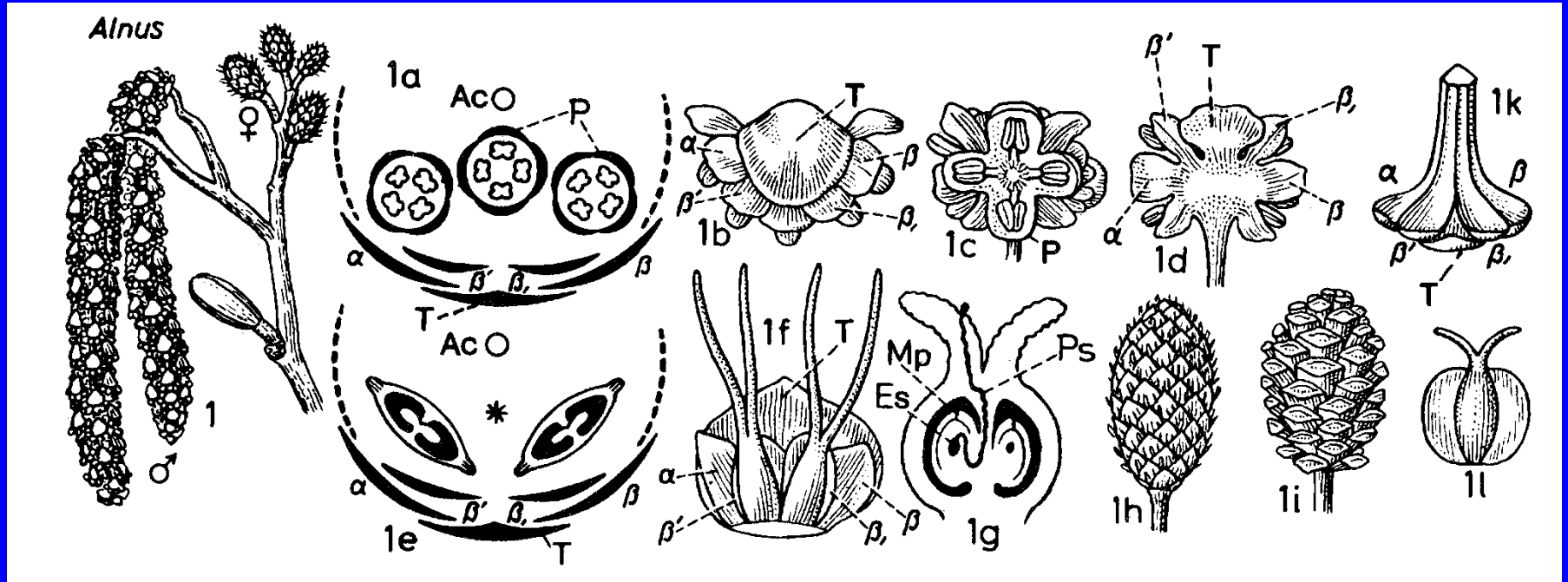


Betula pendula



(Graf 1975)

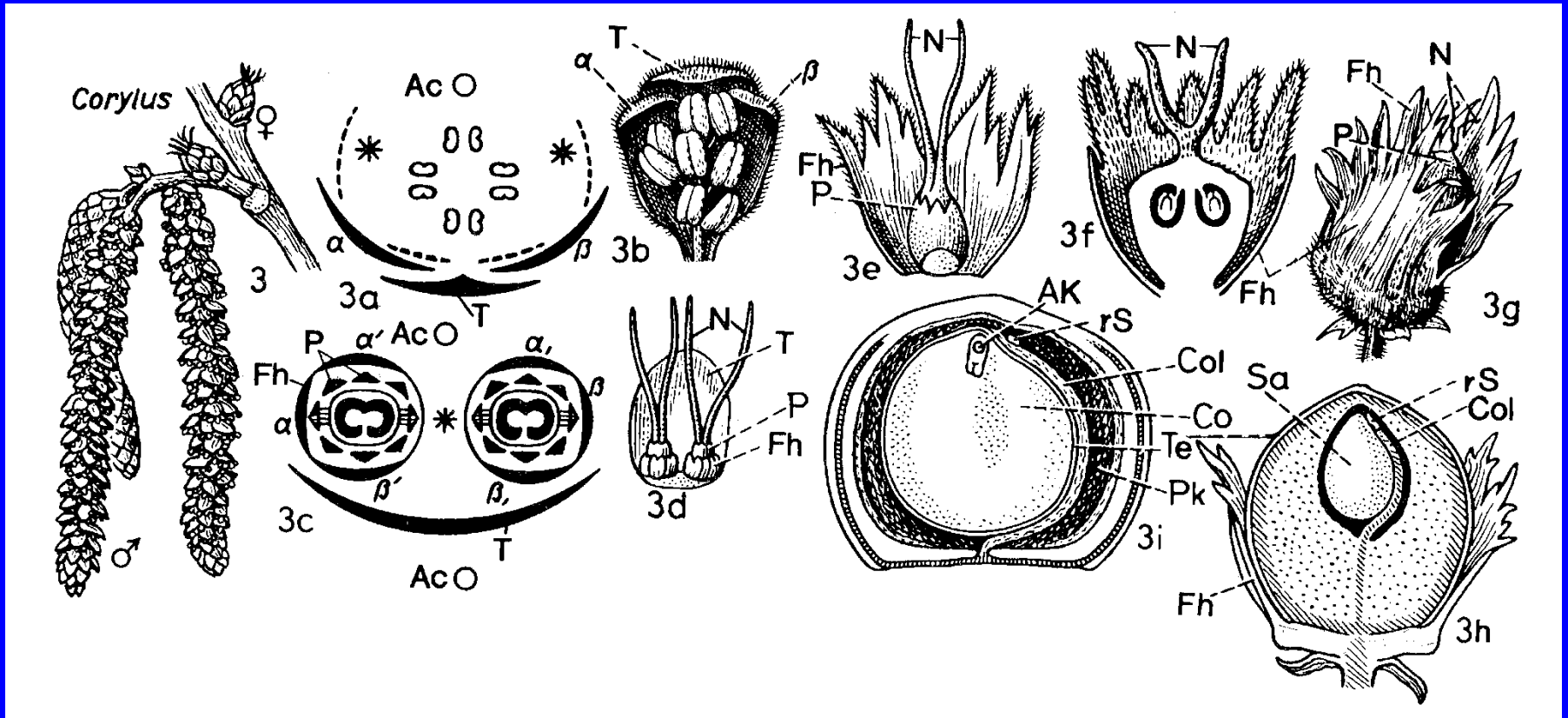
Alnus glutinosa



(Graf 1975)

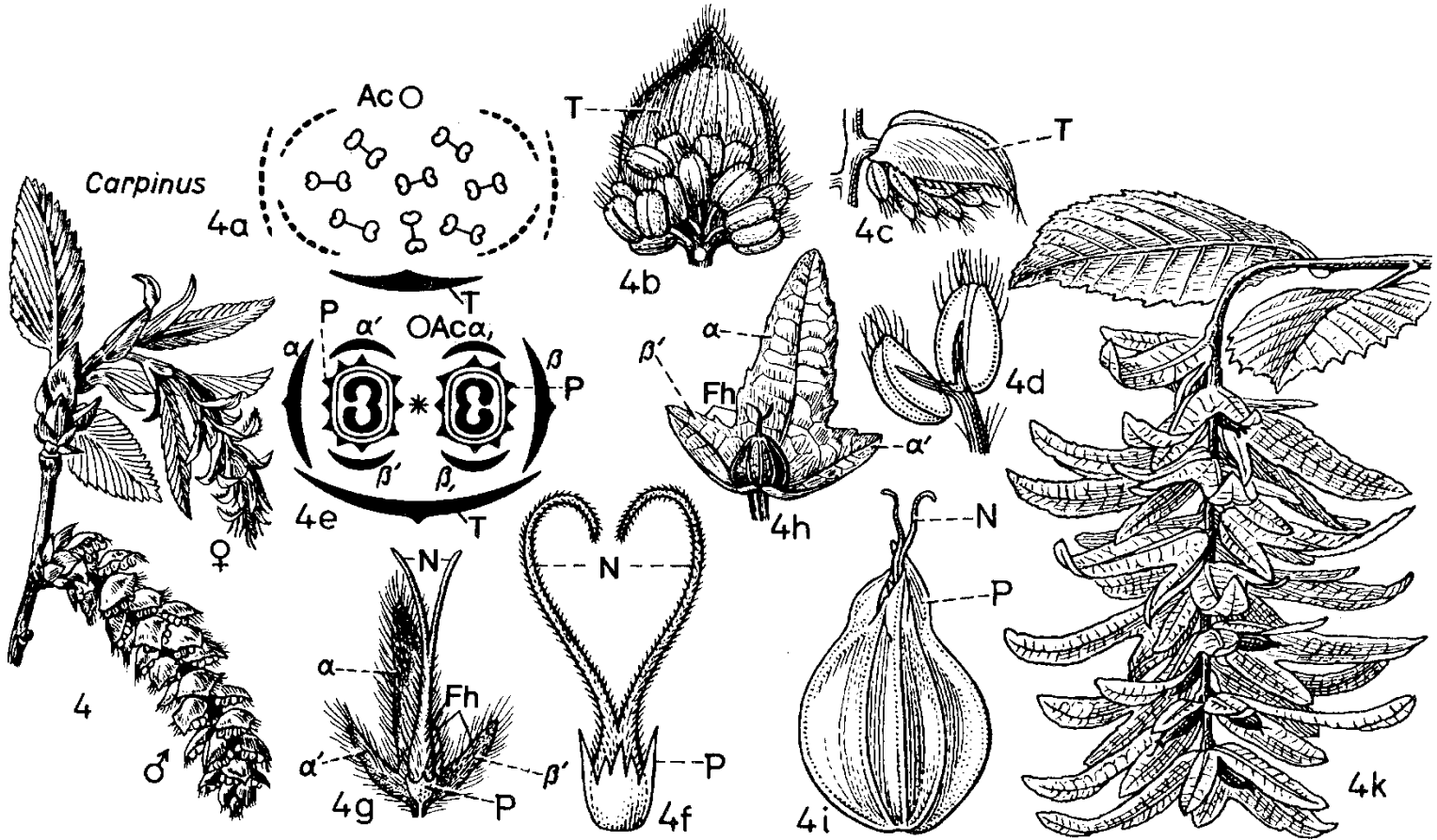
Chalazogamy !

Corylus avellana



(Graf 1975)

Carpinus betulus



(Graf 1975)

Betuloideae vs Coryloideae : floral morphology

<i>Character</i>	<i>Betuloideae</i>	<i>Coryloideae</i>
St fls per bract	3	1
St fl perianth	++	--
stamen number	2-4	3-many
anthers	glabrous	hairy
P fl periant	--	++
fusion	bract with 2-4 bracteoles	bracteoles around fruit
fruit	winged (sometimes reduced)	not winged

Phylogeny of Betulaceae

=

more “trees”...

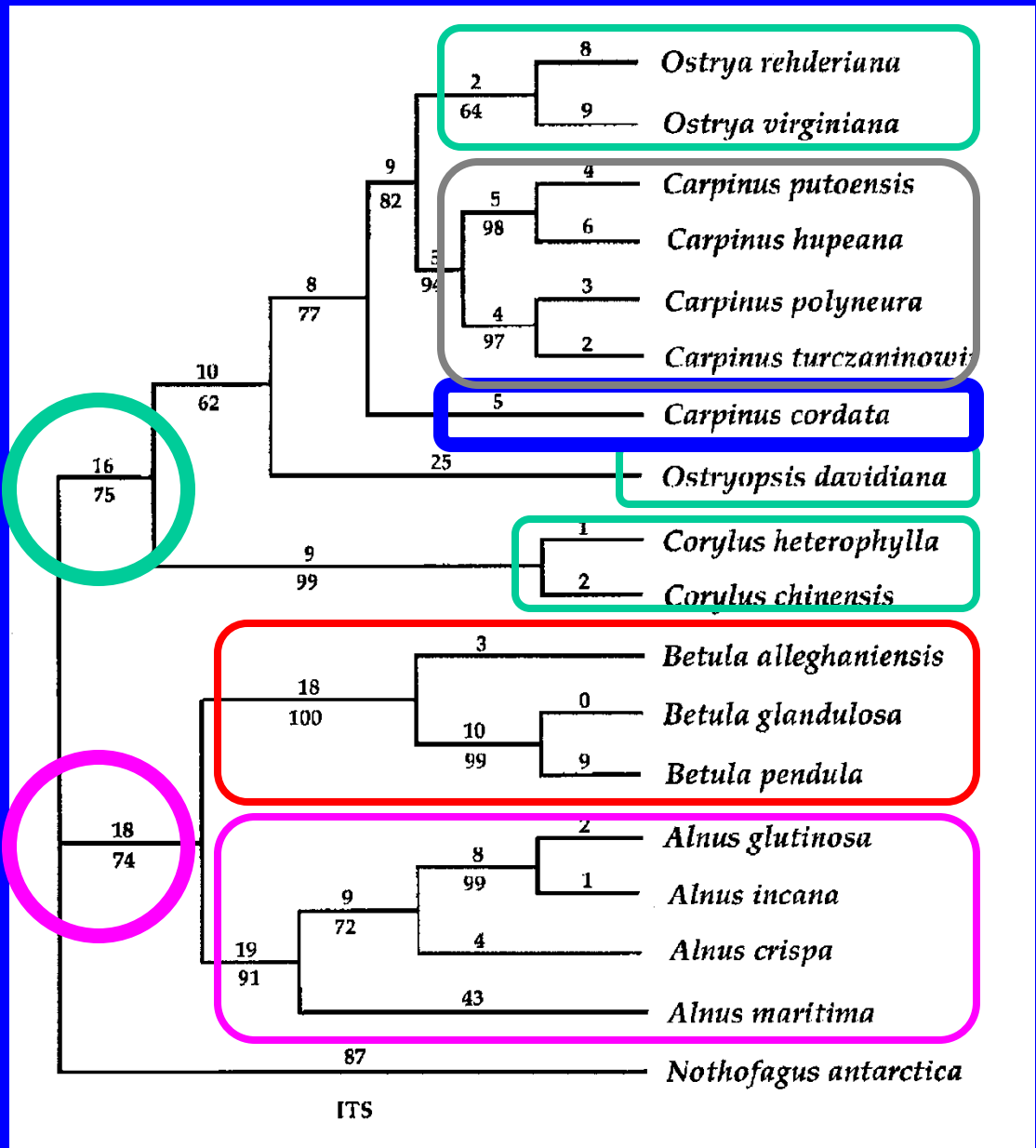
Betulaceae

genus *Distegocarpus* !!!

Coryloideae

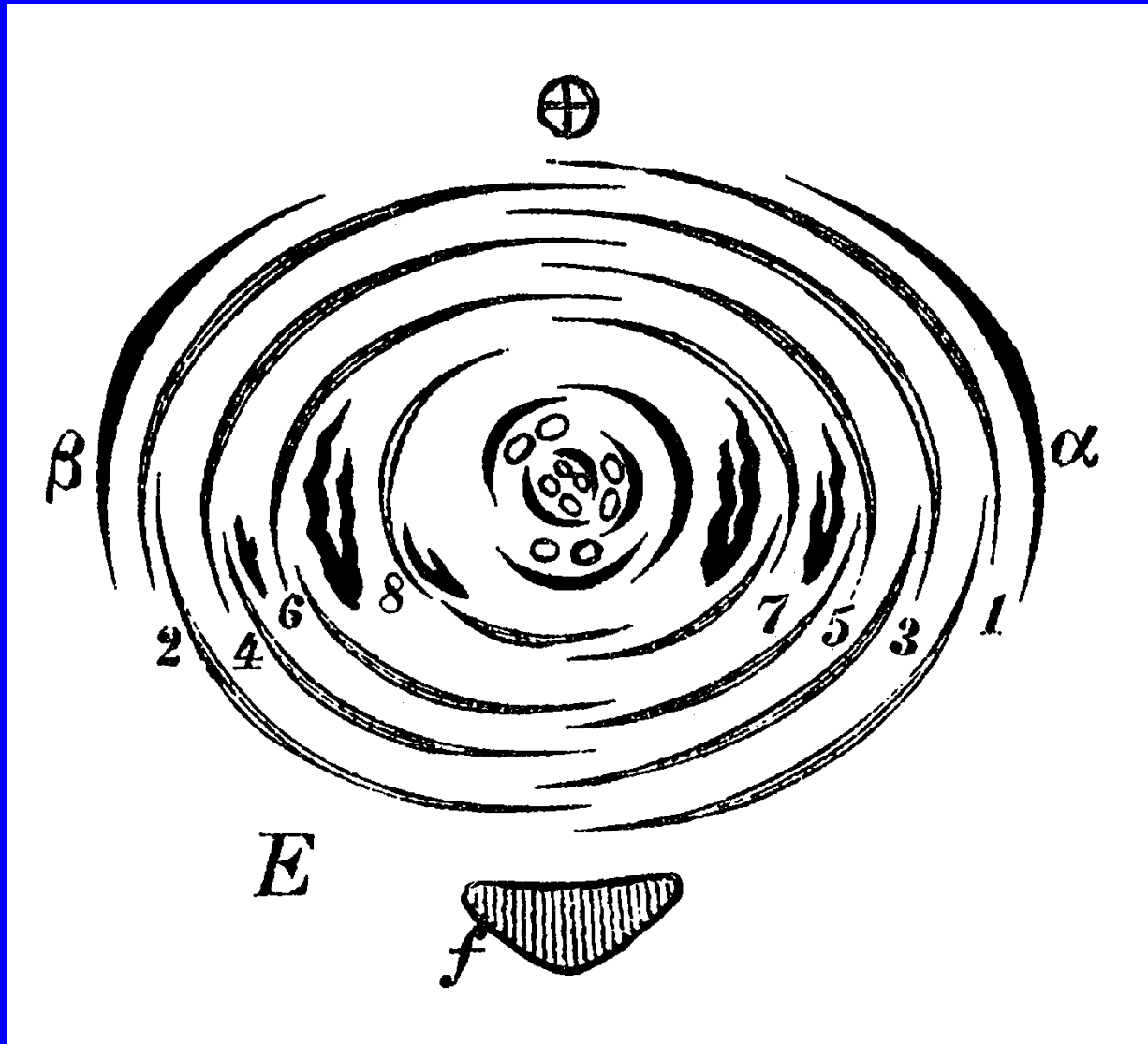
Betuloideae

(Chen et al. 1999)



Coryloideae

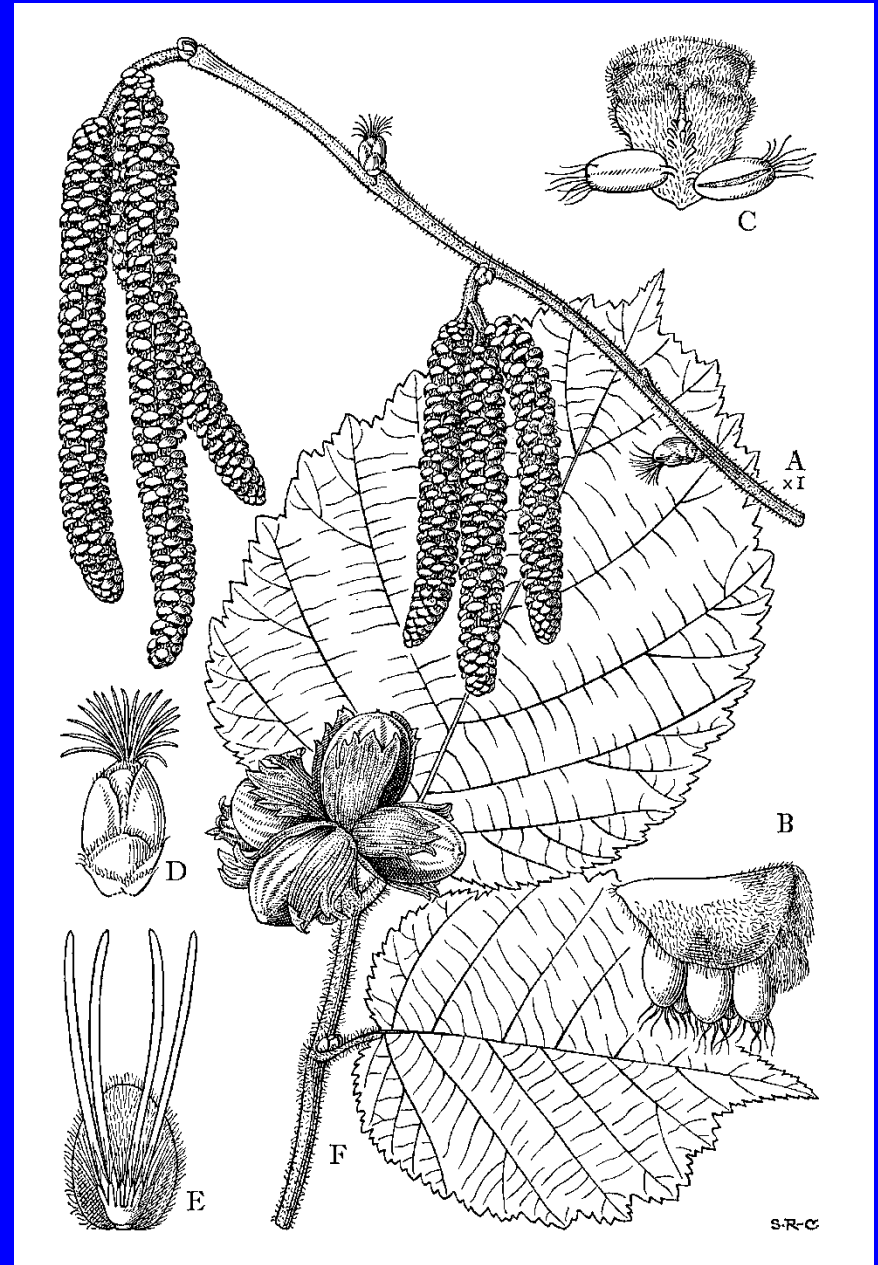
Corylus : bud morphology



(Eichler 1878)

Corylus avellana

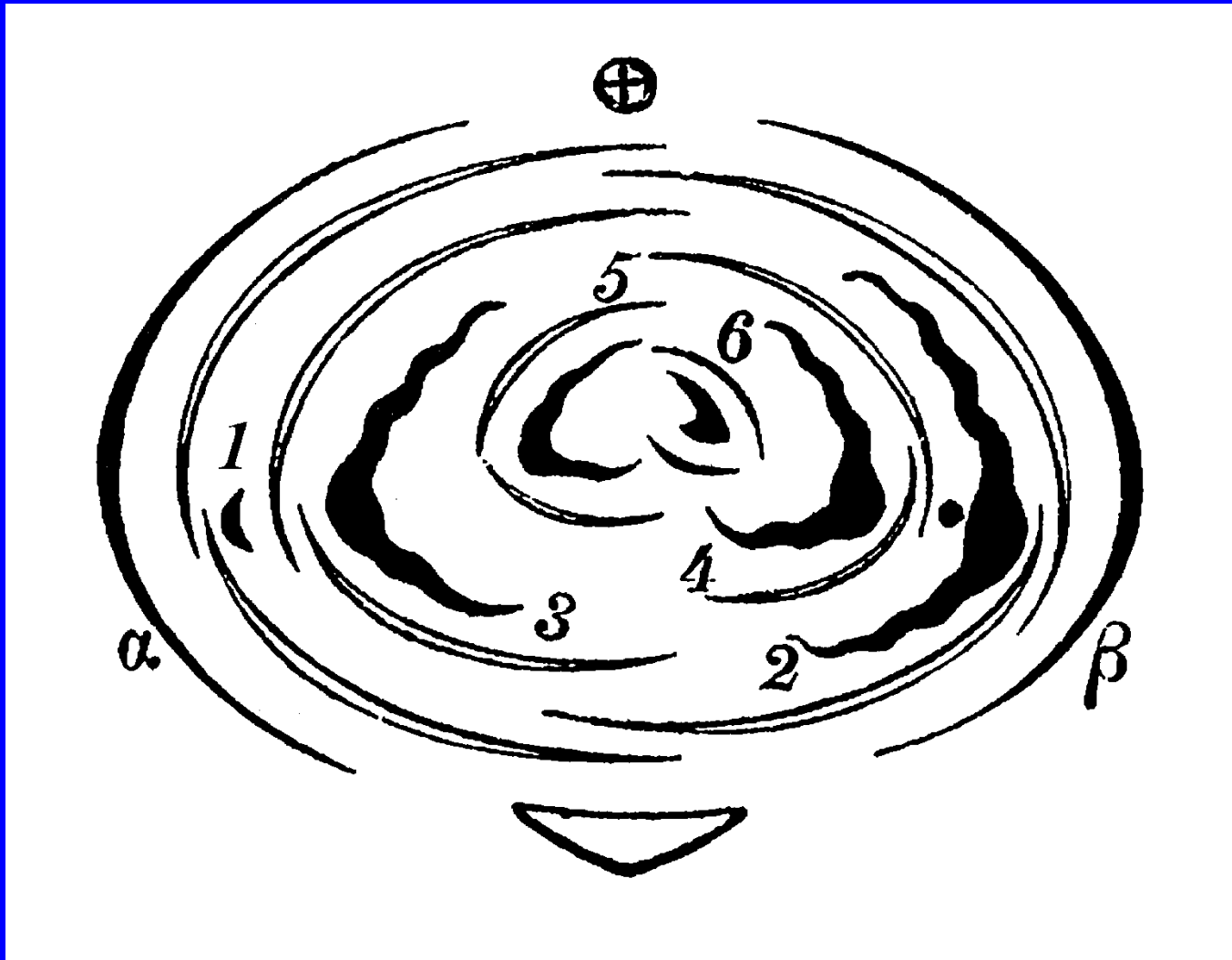
(Ross-Craig 1979)



Corylus avellana

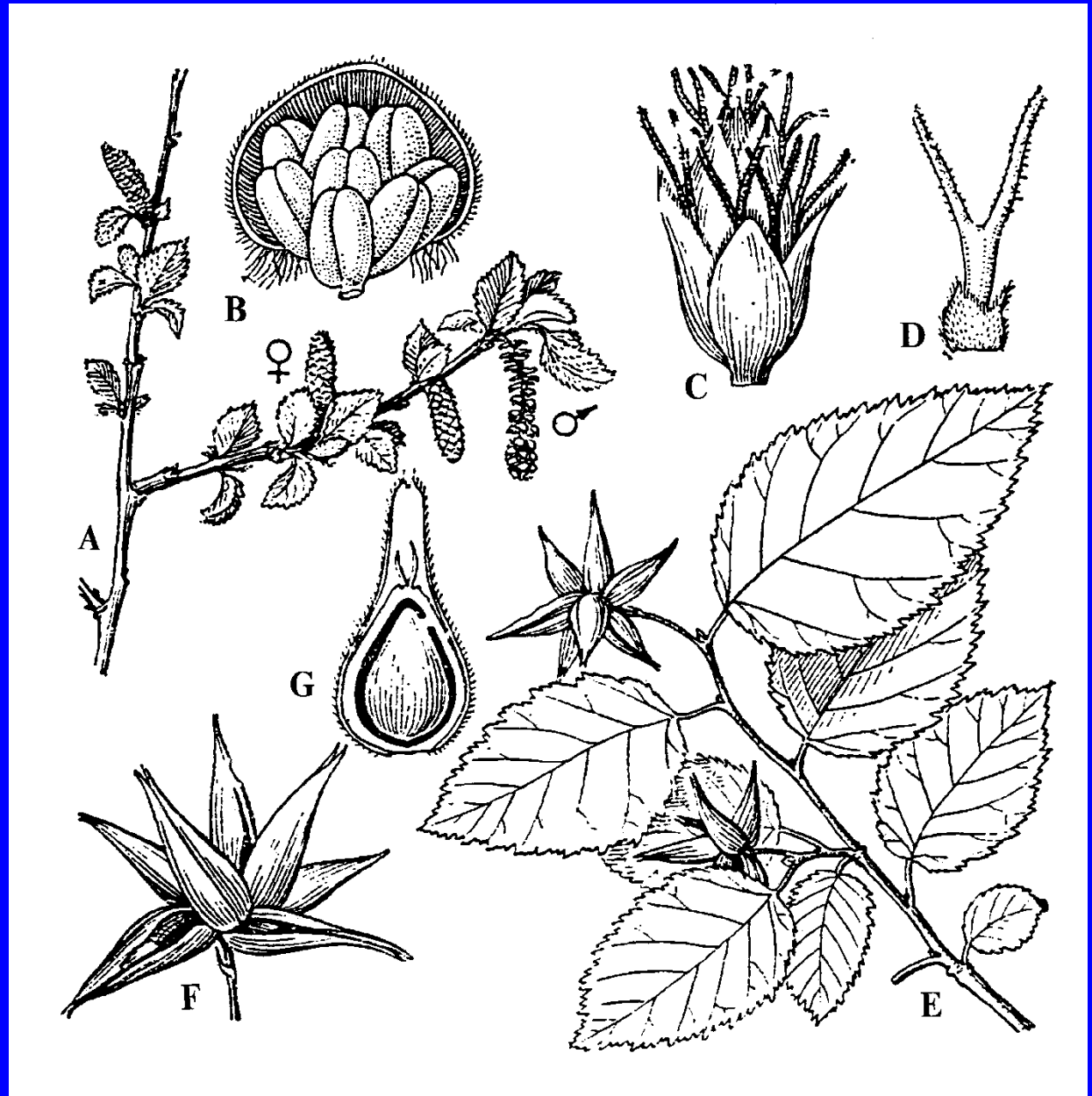


Other Coryloideae : bud morphology



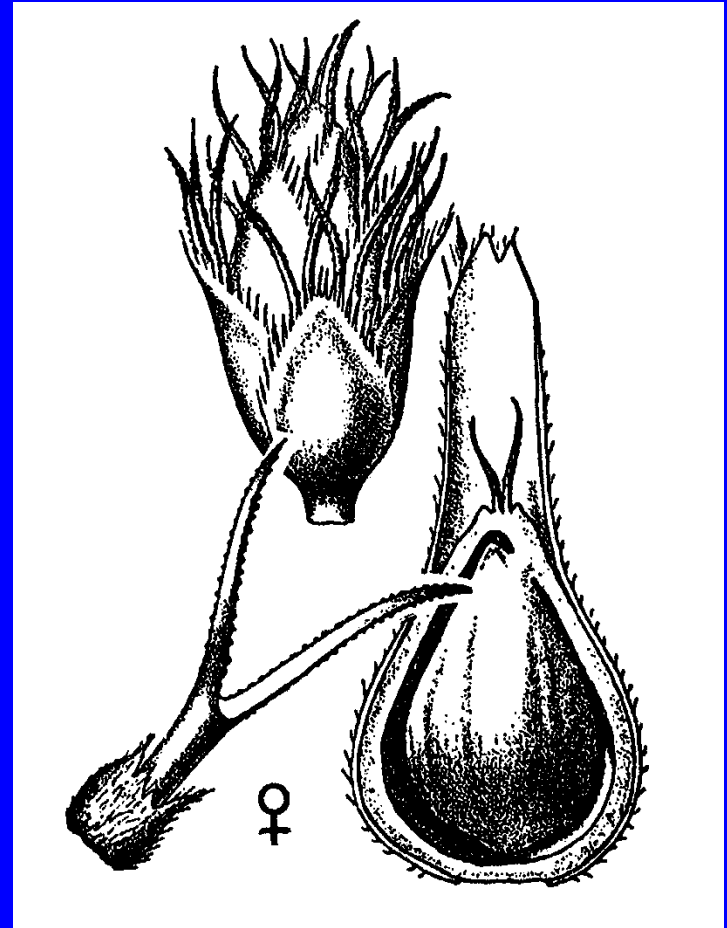
(Eichler 1878)

*Ostryopsis
nobilis*



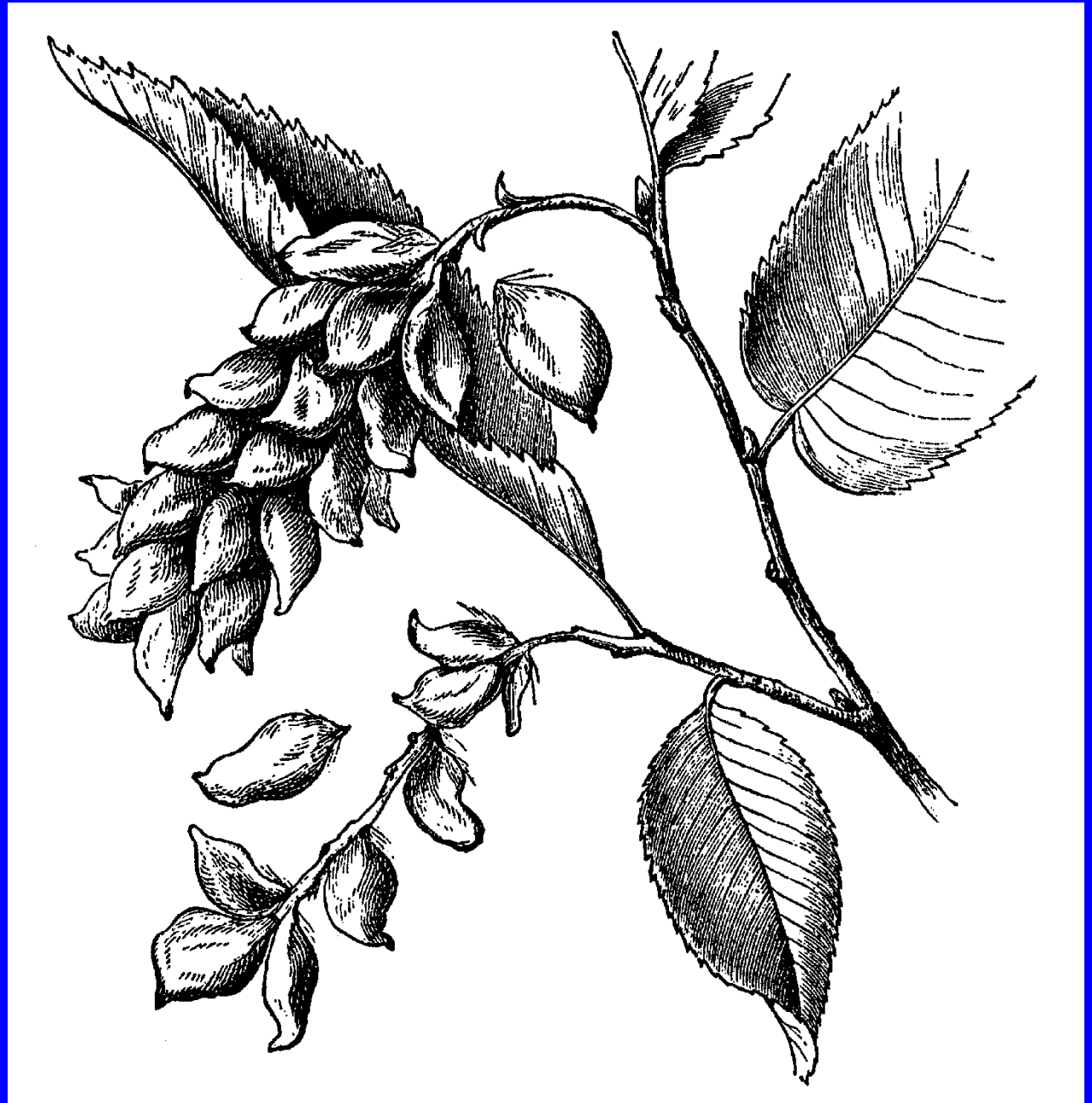
(Kubitzki 1993)

Ostryopsis davidiana



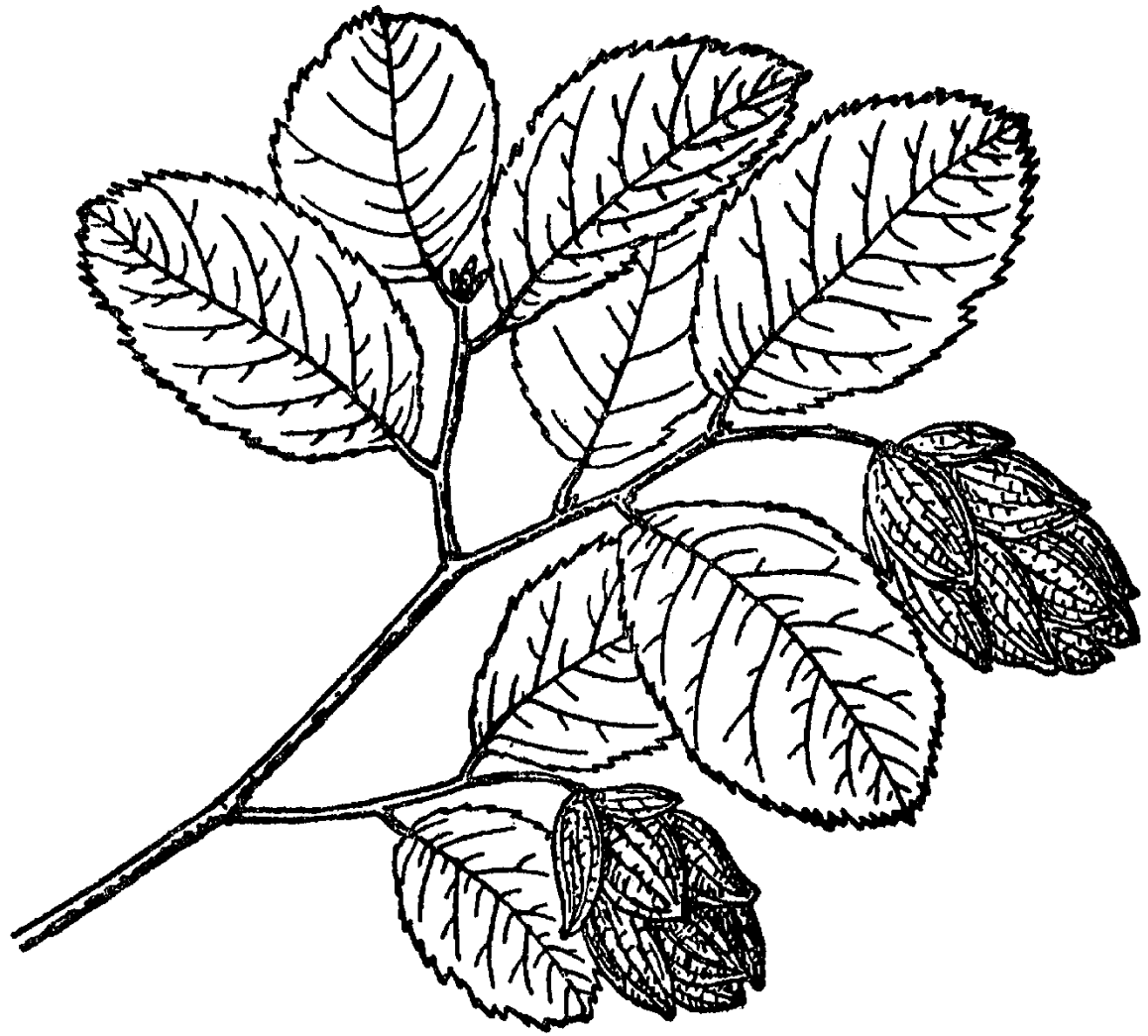
(Krüssmann 1977)

***Ostrya*
*carpinifolia***



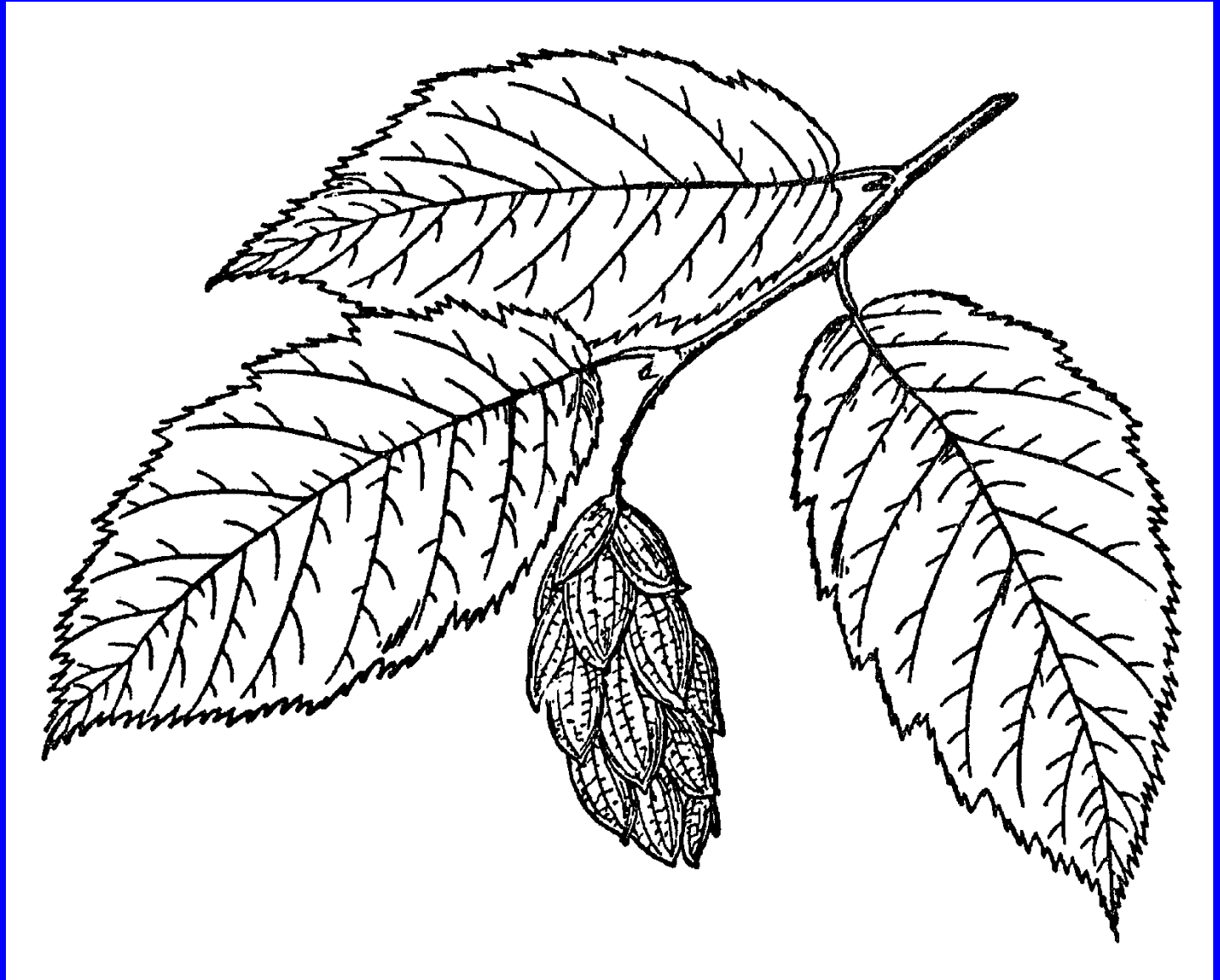
(Krüssmann 1977)

*Ostrya
knowltonii*



(Krüssmann 1977)

Ostrya virginiana



(Krüssmann 1977)

Carpinus

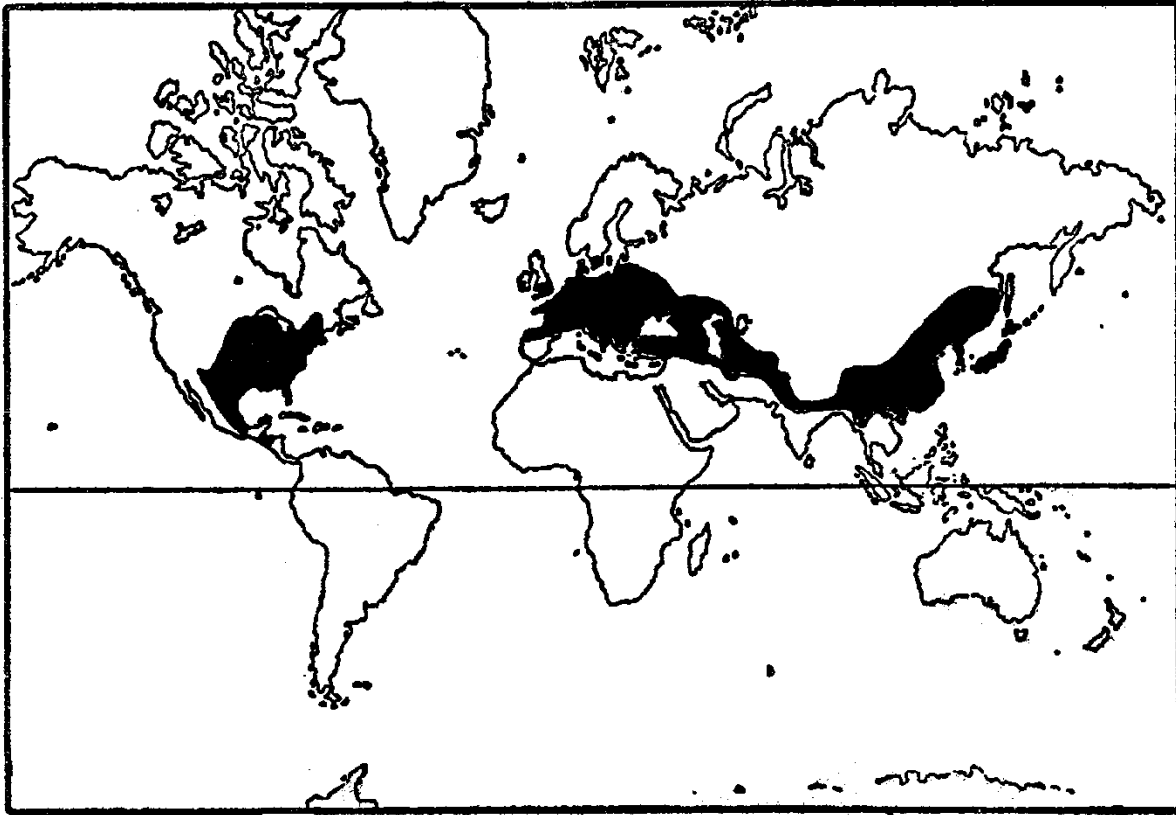


Abb. 190. Arealkarte *Carpinus*

(Krüssmann 1976)

Carpinus

Sectio Carpinus

subsectio Carpinus

C. betulus + 6

subsectio Monbeigiana

C. monbeigiana + 17

subsectio Polyneurae

C. polyneura + 4

Sectio Distegocarpus

Carpinus japonica

C. cordata

C. fangiana

C. rankanensis

(Rushforth 1985, p.p. based on Li 1979)

Carpinus : 2 sections = 2 separate clades !

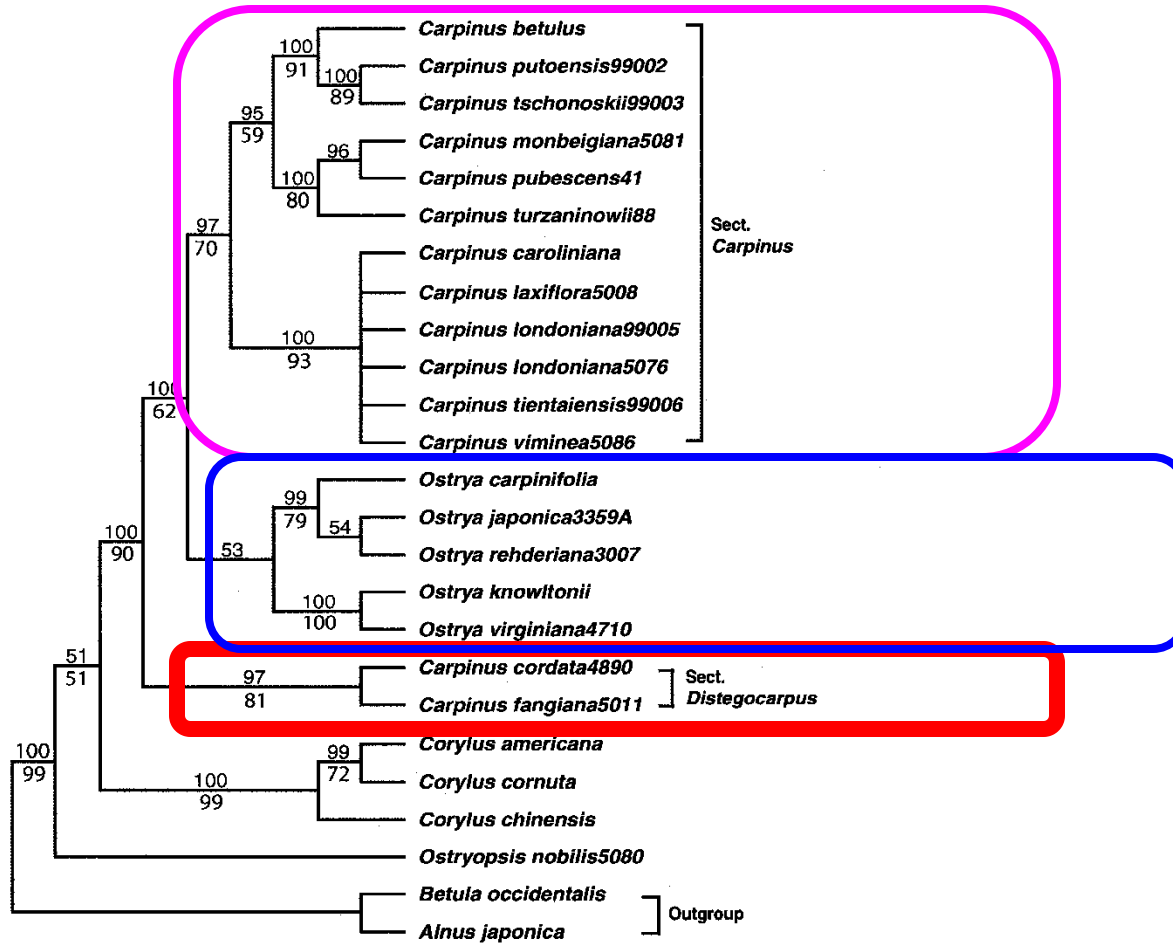


Fig. 2. The strict consensus tree of *Carpinus* and the Coryloideae based on the ITS data with gaps treated as missing data. The Bayesian posterior probabilities are shown above the clades, and the bootstrap values higher than 50% in 500 replicates below the clades

Carpinus

Sectio Carpinus

subsectio Carpinus

C. betulus + 6

subsectio Monbeigiana

C. monbeigiana + 17

subsectio Polyneurae

C. polyneura + 4

Sectio Distegocarpus

Carpinus japonica

C. cordata

C. fangiana

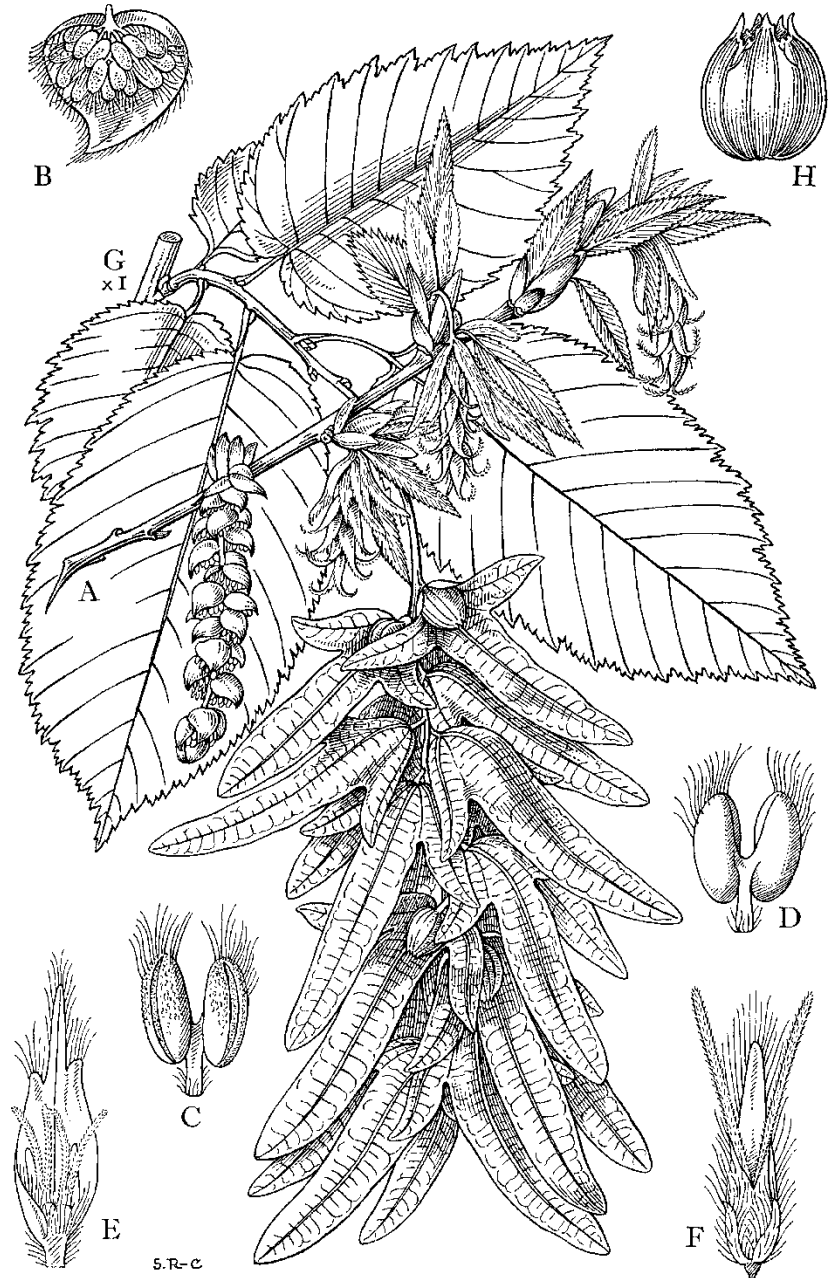
C. rankanensis

(Rushforth 1985, p.p. based on Li 1979)

Carpinus betulus

sectio *Carpinus*

subsectio *Carpinus*



(Ross-Craig 1979)

Carpinus betulus

subsectio *Carpinus*



Carpinus caroliniana

subsectio Monbeigianae ?



Carpinus

Sectio Carpinus

subsectio Carpinus

C. betulus + 6

subsectio Monbeigiana

C. monbeigiana + 17

subsectio Polyneurae

C. polyneura + 4

Sectio Distegocarpus

Carpinus japonica

C. cordata

C. fangiana

C. rankanensis

(Rushforth 1985, p.p. based on Li 1979)

Carpinus fargesiana
Carpinus monbeigiana
Carpinus turczaninowii

subsectio Monbeigianae

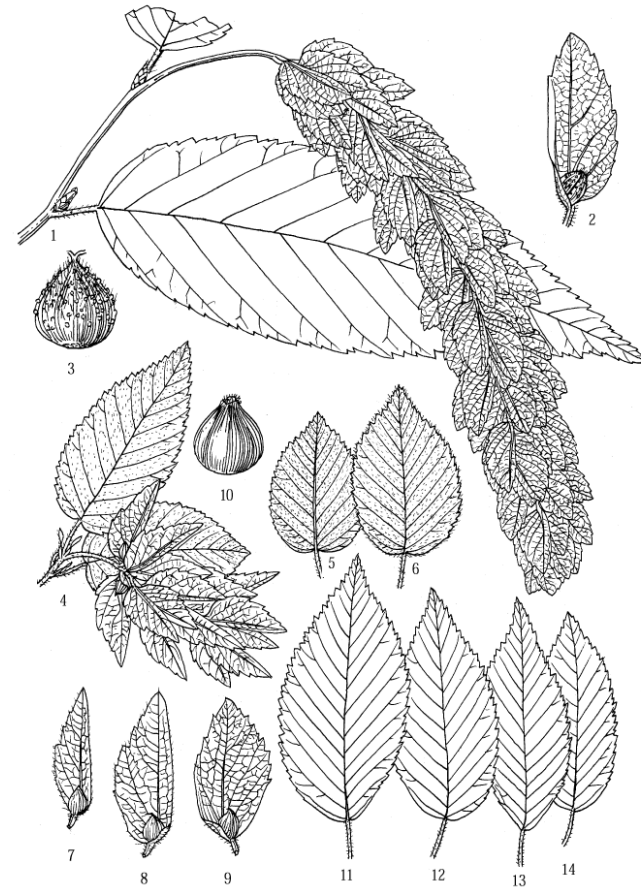


Figure 281. 1–3. *Carpinus monbeigiana* Handel-Mazzetti, 云南鹅耳枥 yun nan e er li. —1. Leaves and infructescence. —2. Bract with nutlet. —3. Nutlet. 4–10. *C. turczaninowii* Hance, 鹅耳枥 e er li. —4. Leaves and infructescence. —5, 6. Leaves. —7–9. Bract with nutlets. —10. Nutlet. 11–14. *C. fargesiana* H. Winkler var. *fargesiana*, 川陕鹅耳枥 (原变种) chuan shan e er li (yuan bian zhong). —11–14. Leaves. (FOC 294, 297, 298; FRPS 21: 78, pl. 19. 1979. —冯晋庸 Feng Jinyong; redrawn by 孙英宝 Sun Yingbao).

(Li & Skvortzov 1999)

Carpinus turczaninowii *subsectio Monbeigianae*



Carpinus

Sectio Carpinus

subsectio Carpinus

C. betulus + 6

subsectio Monbeigiana

C. monbeigiana + 17

subsectio Polyneurae

C. polyneura + 4

Sectio Distegocarpus

Carpinus japonica

C. cordata

C. fangiana

C. rankanensis

(Rushforth 1985, p.p. based on Li 1979)

Carpinus mollicoma
Carpinus polyneura
Carpinus tschonoskii

subsectio *Polyneurae*



Figure 282. 1-6. *Carpinus tschonoskii* Maximowicz, 昌化鹅耳枥 chang hua e er li. —1. Leaves and inflorescence. —2-4. Leaves. —5. Bract with nutlet. —6. Nutlet. 7-9. *C. polyneura* Franchet, 多脉鹅耳枥 duo mai e er li. —7. Leaves and inflorescence. —8. Bract with nutlet. —9. Nutlet. 10-13. *C. mollicoma* Hu, 软毛鹅耳枥 ruan mao e er li. —10. Leaves and inflorescence. —11. Bract with nutlet. —12. Nutlet. —13. Leaf blade portion abaxial view. (FOC 298, 299; FRPS 21: 87, pl. 21. 1979. —冯晋庸 Feng Jinyong; redrawn by 孙英宝 Sun Yingbao).

(Li & Skvortzov 1999)

Carpinus tschonoskii

subsectio Polyneurae



Carpinus

Sectio Carpinus

subsectio Carpinus

***C. betulus* + 6**

subsectio Monbeigiana

***C. monbeigiana* + 17**

subsectio Polyneurae

***C. polyneura* + 4**

Sectio Distegocarpus

Carpinus japonica

C. cordata

C. fangiana

C. rankanensis

(Rushforth 1985, p.p. based on Li 1979)

Carpinus : 2 sections = 2 separate clades !

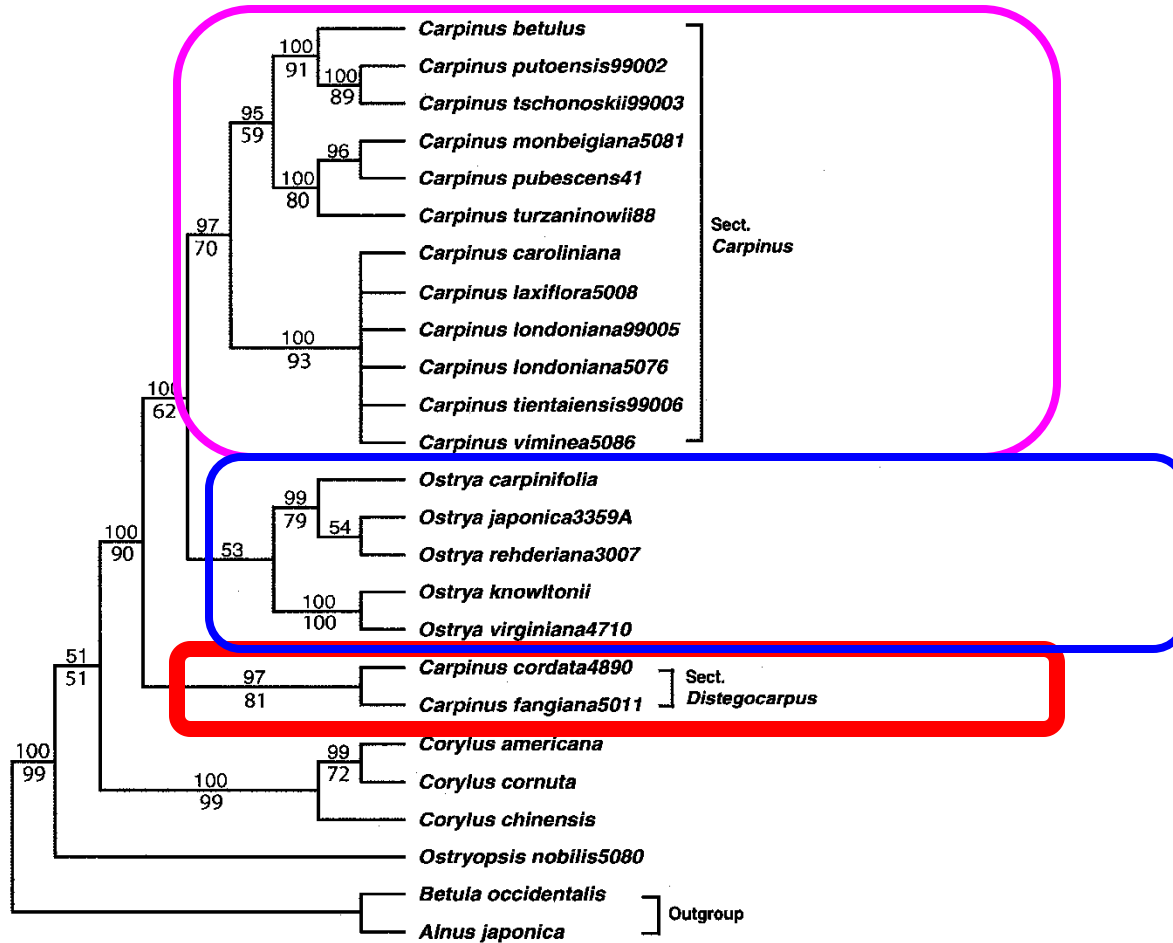


Fig. 2. The strict consensus tree of *Carpinus* and the Coryloideae based on the ITS data with gaps treated as missing data. The Bayesian posterior probabilities are shown above the clades, and the bootstrap values higher than 50% in 500 replicates below the clades

Carpinus japonica sectio *Distegocarpus*



Carpinus japonica

sectio Distegocarpus



(Kurata 1964)

Carpinus cordata sectio *Distegocarpus*



Carpinus cordata - grab sercowaty

Carpinus cordata sectio *Distegocarpus*



Carpinus cordata - grab sercowaty

<http://fotobabij.blogspot.com>

Carpinus fangiana

sectio Distegocarpus



Carpinus cordata *Carpinus fangiana*

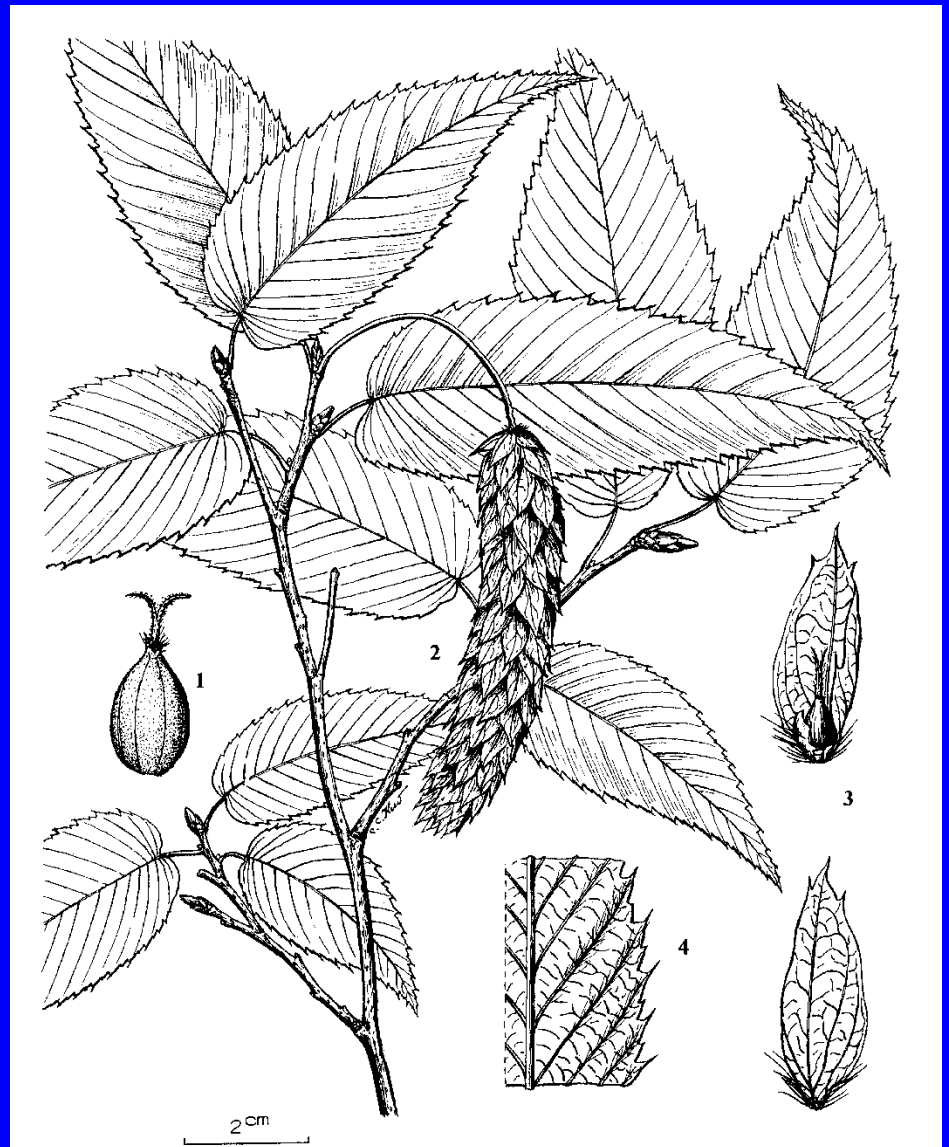
sectio *Distegocarpus*



Figure 276. 1–3. *Carpinus cordata* Blume var. *cordata*, 千斤榆 (原变种) qian jin yu (yuan bian zhong). —1. Leaves and infructescence. —2. Bract. —3. Nutlet. 4. *C. cordata* var. *chinensis* Franchet, 华千斤榆 hua qian jin yu. —4. Leaves and infructescence. 5, 6. *C. fangiana* Hu, 川黔千斤榆 chuan qian qian jin yu. —5. Leaves and infructescence. —6. Nutlet with bract. (FOC 291, 292; FRPS 21: 66, pl. 15. 1979. —冯晋庸 Feng Jinyong; redrawn by 孙英宝 Sun Yingbao).

Carpinus rankanensis

sectio Distegocarpus



P1. 206. *Carpinus rankanensis* Hayata (BETULACEAE)

1, nutlet; 2, branch with fruiting catkin; 3, leafy bract enclosing nutlet; 4, venation & serration of leaf.

(Li 1976)

Carpinus japonica sectio *Distegocarpus*



Carpinus cordata *sectio Distegocarpus*



Bad news: "Distegocarpus" is heterogeneous ?

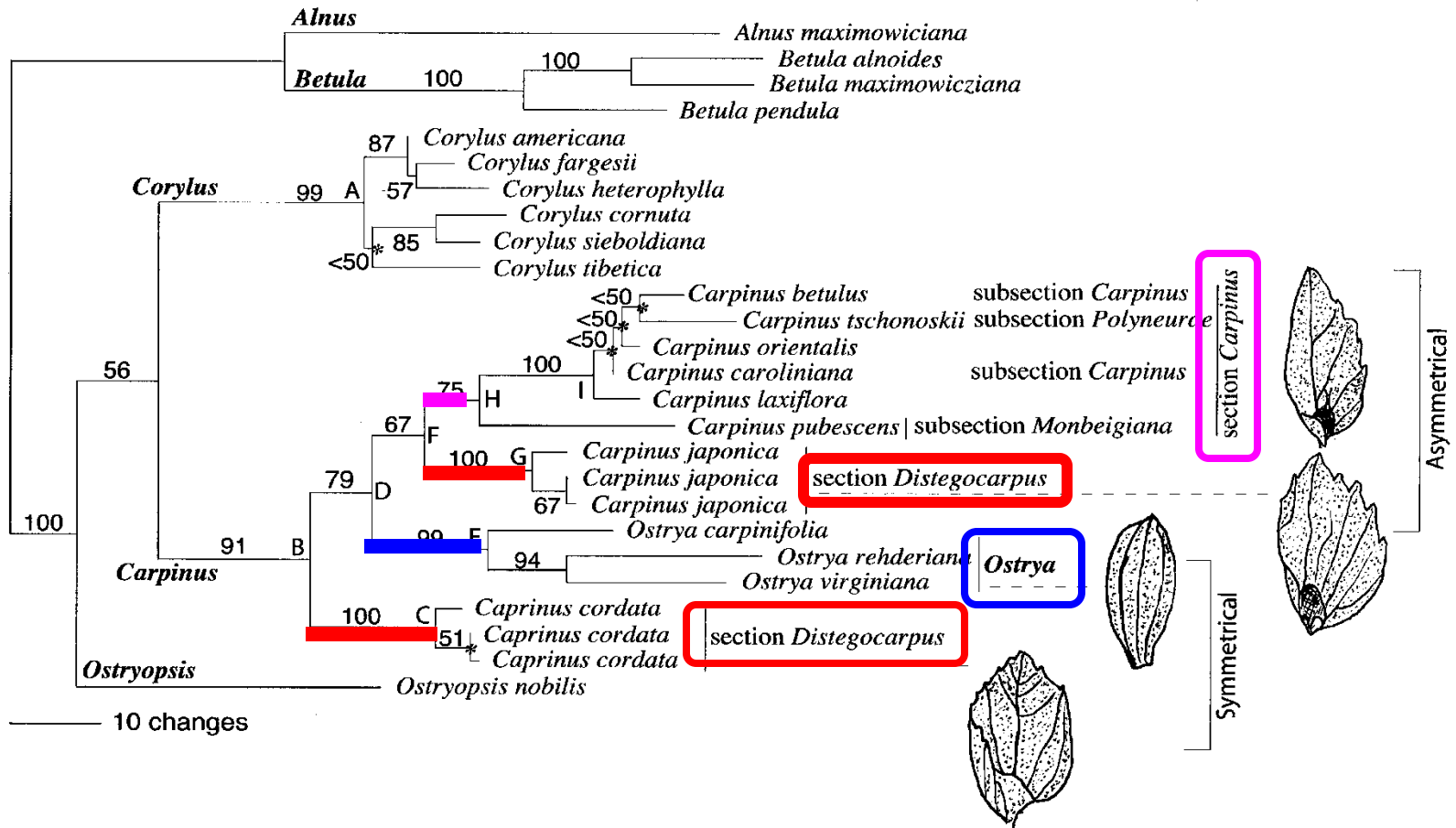
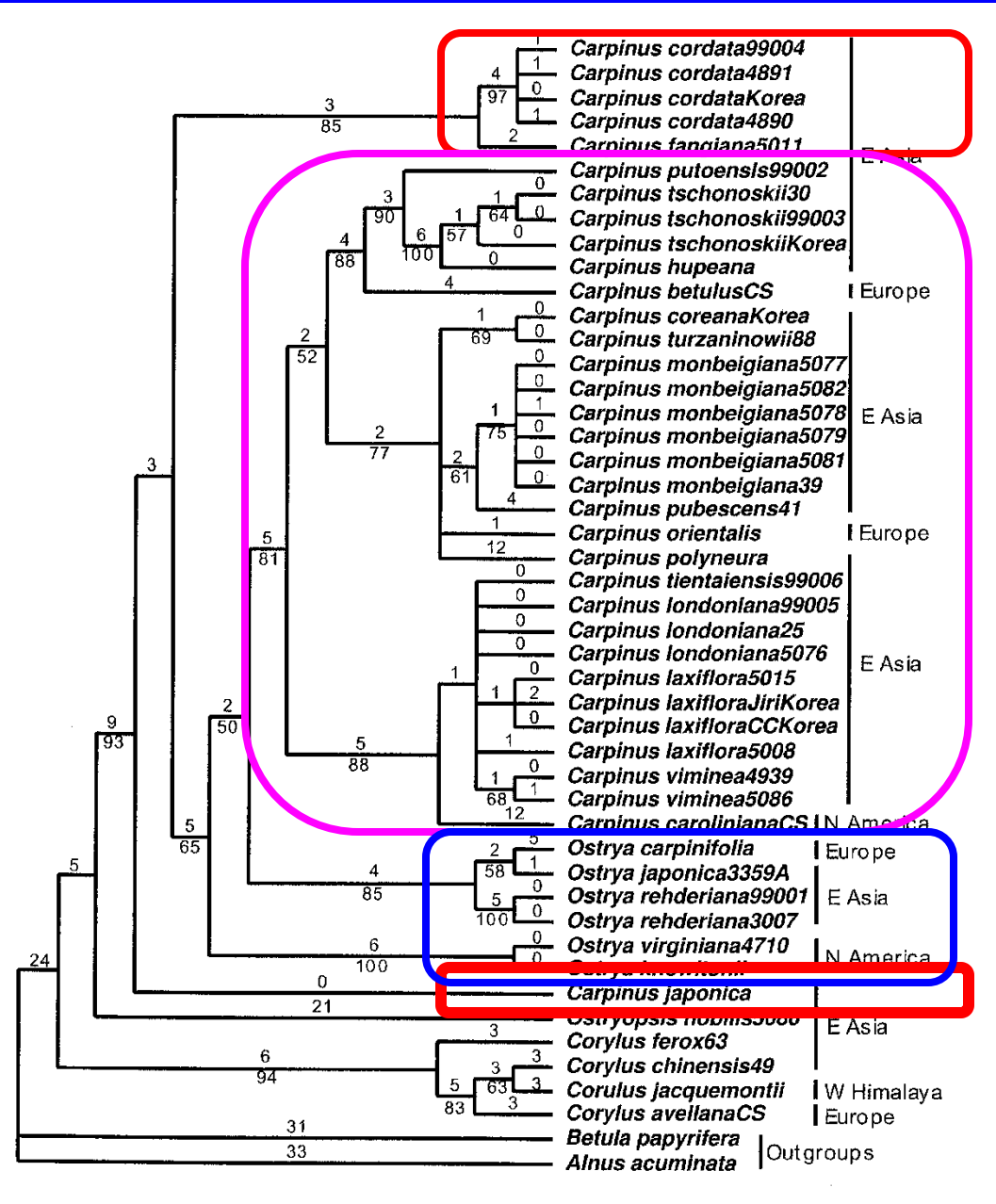


Fig. 2. One of 180 parsimonious trees of 506 steps ($CI=0.85$ and $RI=0.87$) based on sequences of nitrate reductase. Numbers at branches are percentages of bootstrap support. Asterisks denote clades absent in the strict consensus tree. *Alnus* and *Betula* are outgroups.

Another phylogeny of *Carpinus*



(Yoo & Wen 2002)

C. cordata
C. japonica

sectio *Distegocarpus*

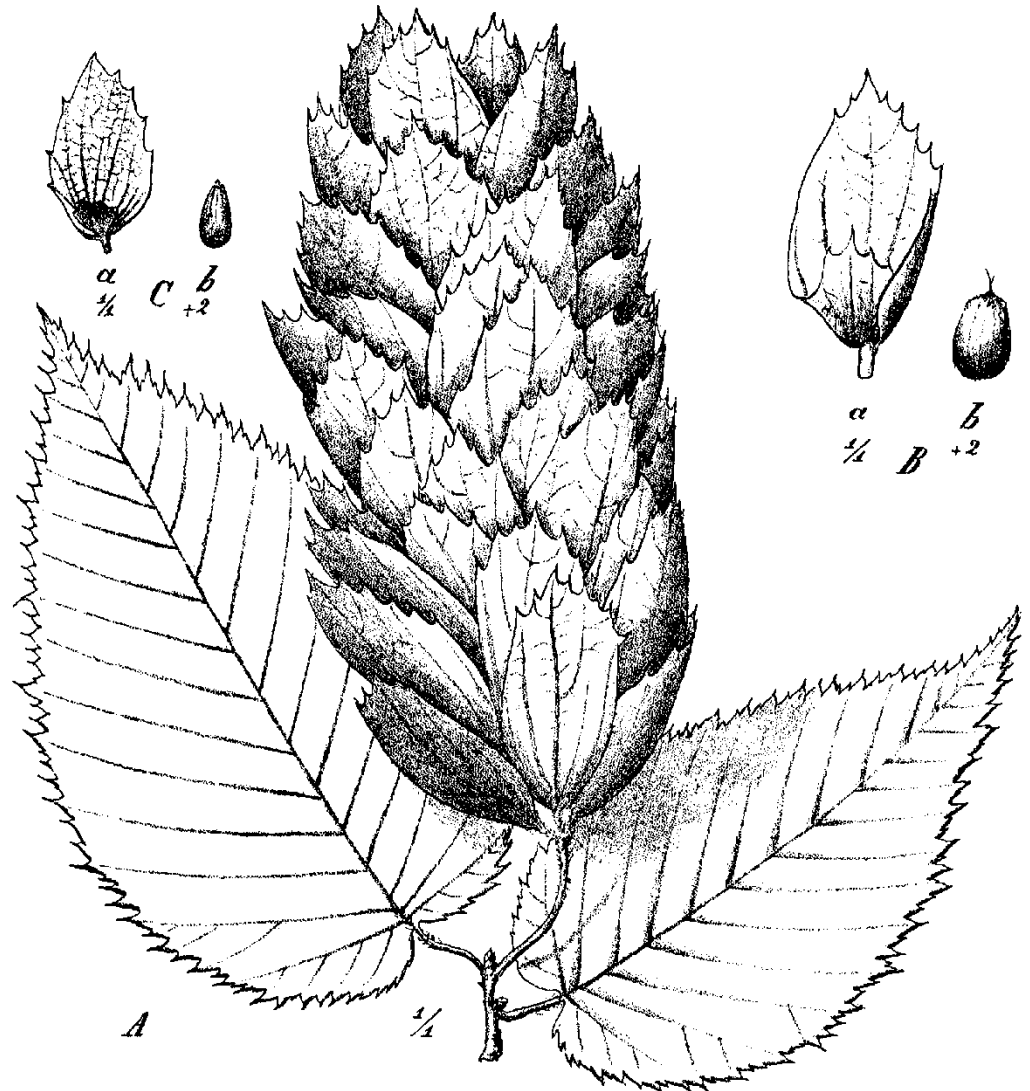


Fig. 8. A, B *Carpinus cordata* Blume. A Ramulus fructifer. B Fructus, a bractea fructifera, b nucula. — C *Carpinus japonica* Blume. Fructus, a bractea fructifera, b nucula. (Icon origin.).

(Winkler 1904)

C. cordata, C. japonica *sectio Distegocarpus*

Winkler 1904

sectio Distegocarpus

A. Bractea basi inflexa nuculam amplectens

Carpinus cordata

B. Ligula nuculam tegens bractee opposita non accreta

Carpinus japonica

Concluding for Carpinus (1) :

***Carpinus japonica*, the type species of the former genus**

***Distegocarpus*, is morphologically deviating from the section *Carpinus* by its fruit covered by two separate scales.**

However, genetically it is the sister group of the typical section *Carpinus* !

***Carpinus cordata* (and other species of *Distegocarpus* ?) is / are also morphologically deviating from the section *Carpinus* by the two infolded wings of the fruit-associated compound leaf.**

Genetically is the sister group of the couple (*Ostrya* + section *Carpinus*).

Concluding for Carpinus (2) :

***WANTED
DEAD or ALIVE***

Sectio Distegocarpus

Carpinus japonica

Carpinus cordata

Carpinus fangiana

Carpinus rankanensis

Summary

*Catkins have had multiple origins,
and are often derived from entomophilous ancestors*

Taxonomy : Betulaceae > Fagales > Fabids > rosids

Betulaceae leaves are Iary + IIary craspedodromous

Betulaceae false catkins composed of 3-flowered cymes

Betulaceae clearly divided in Betuloideae & Coryloideae

Carpinus is divided in two sections, C. & Distegocarpus

But ! Distegocarpus seems to be heterogeneous...

Acknowledgments

Jan De Langhe

Arboretum Wespelaar

Belgian Dendrology

Bram Rammeloo

Jef Van Meulder

Thanks ! to whom I forget

