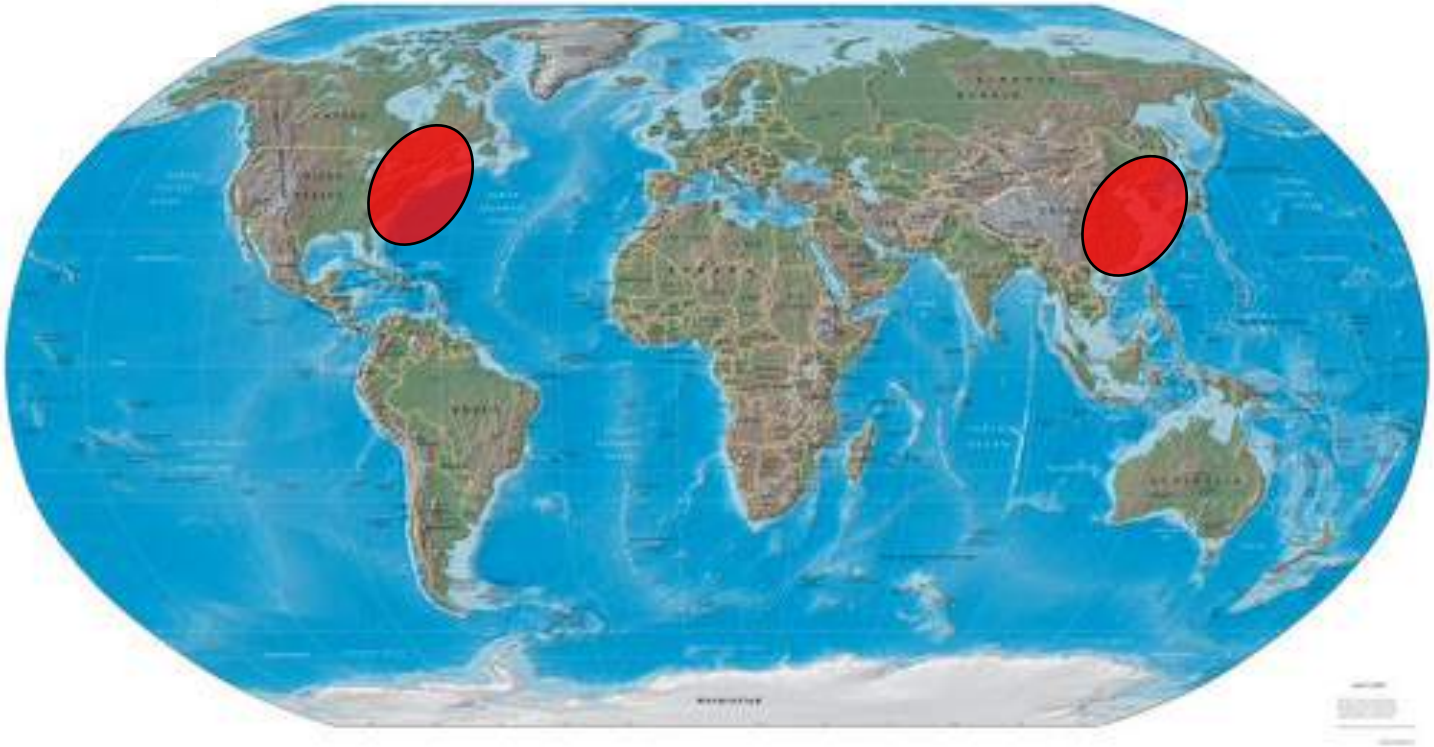
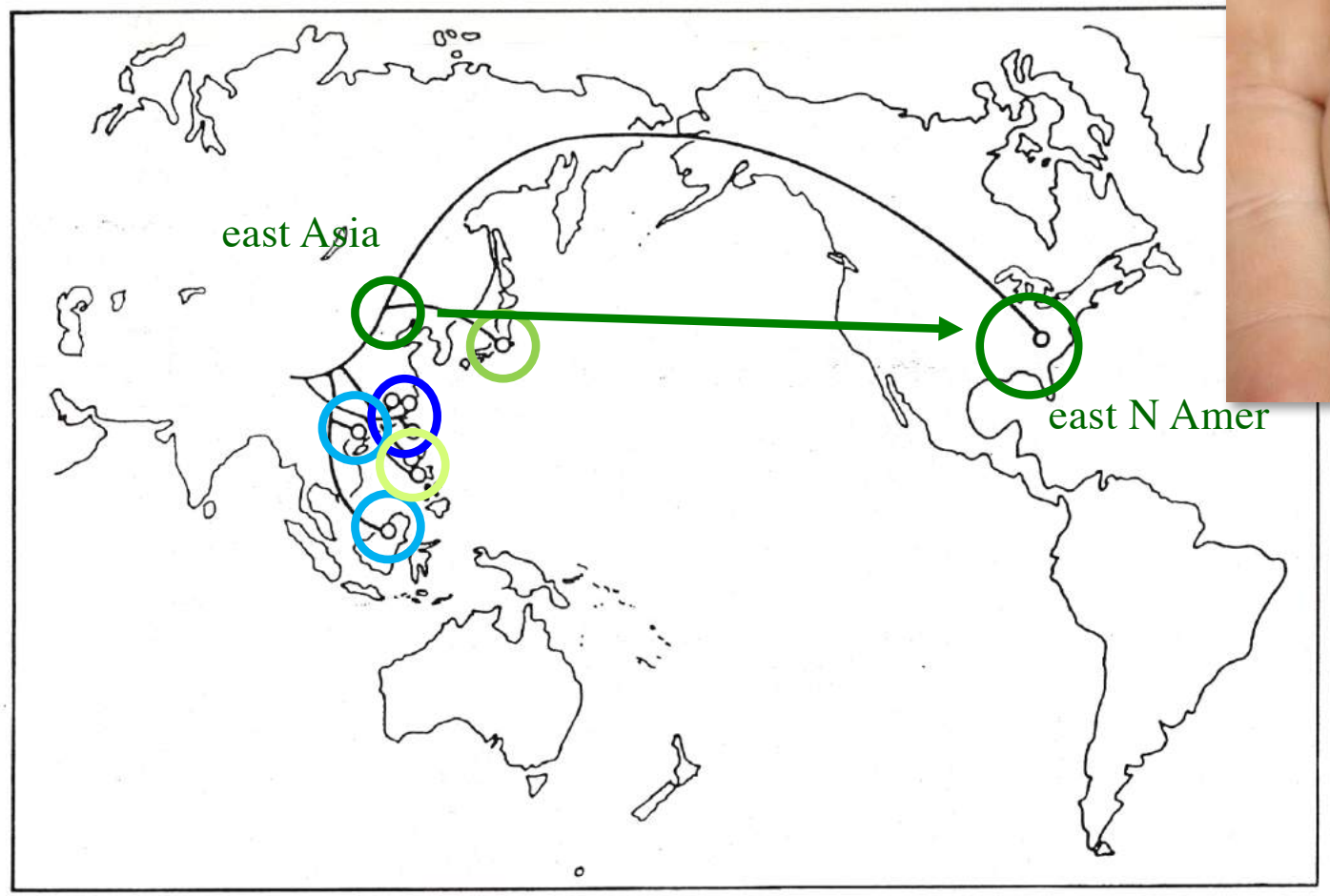
Relationships of Floras & Faunas

Knowledge of earth and organism histories now permit closer examination of relationships of disjunct floras and faunas.

- Southern Hemisphere temperate
- Southern Hemisphere tropics
- the Wallace Line
- **Eastern Asian - Eastern North American temperate**



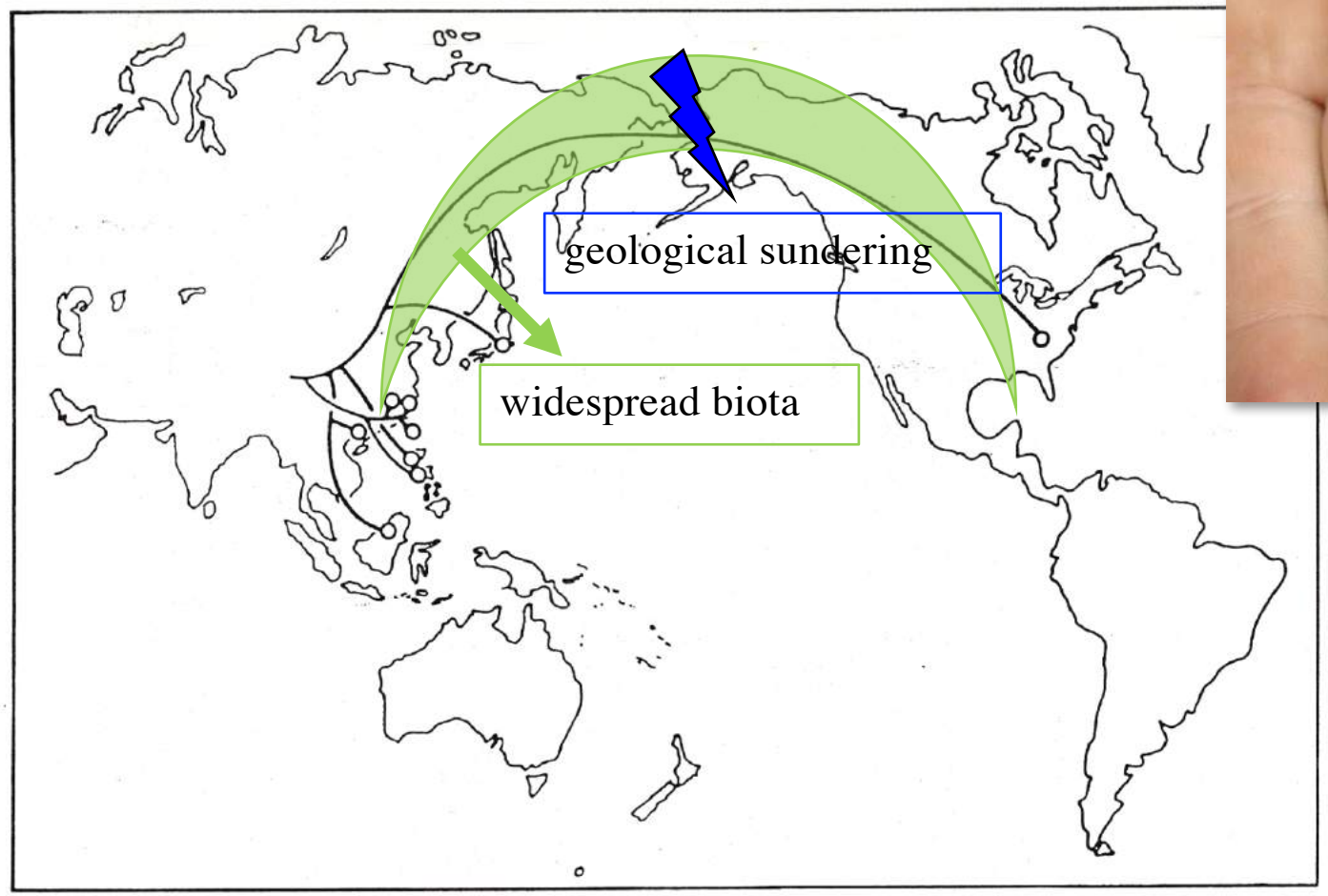
"Phylogenetic biogeographers" interpreted the pattern with dispersalism



Note center of origin and dispersal events and one LDD event

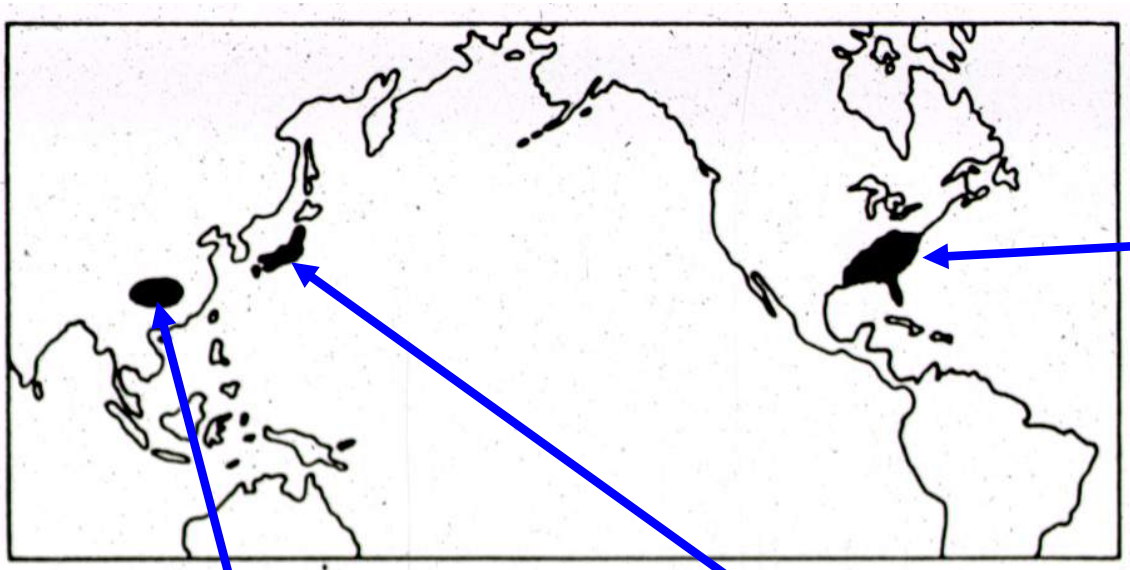
Distribution and phylogeny of *Wormaldia* (caddis flies) — Ross, 1974

"Cladistic biogeographers" interpreted the pattern with vicariance



Distribution and phylogeny of *Wormaldia* (caddis flies) — Ross, 1974

Eastern North America - Eastern Asia



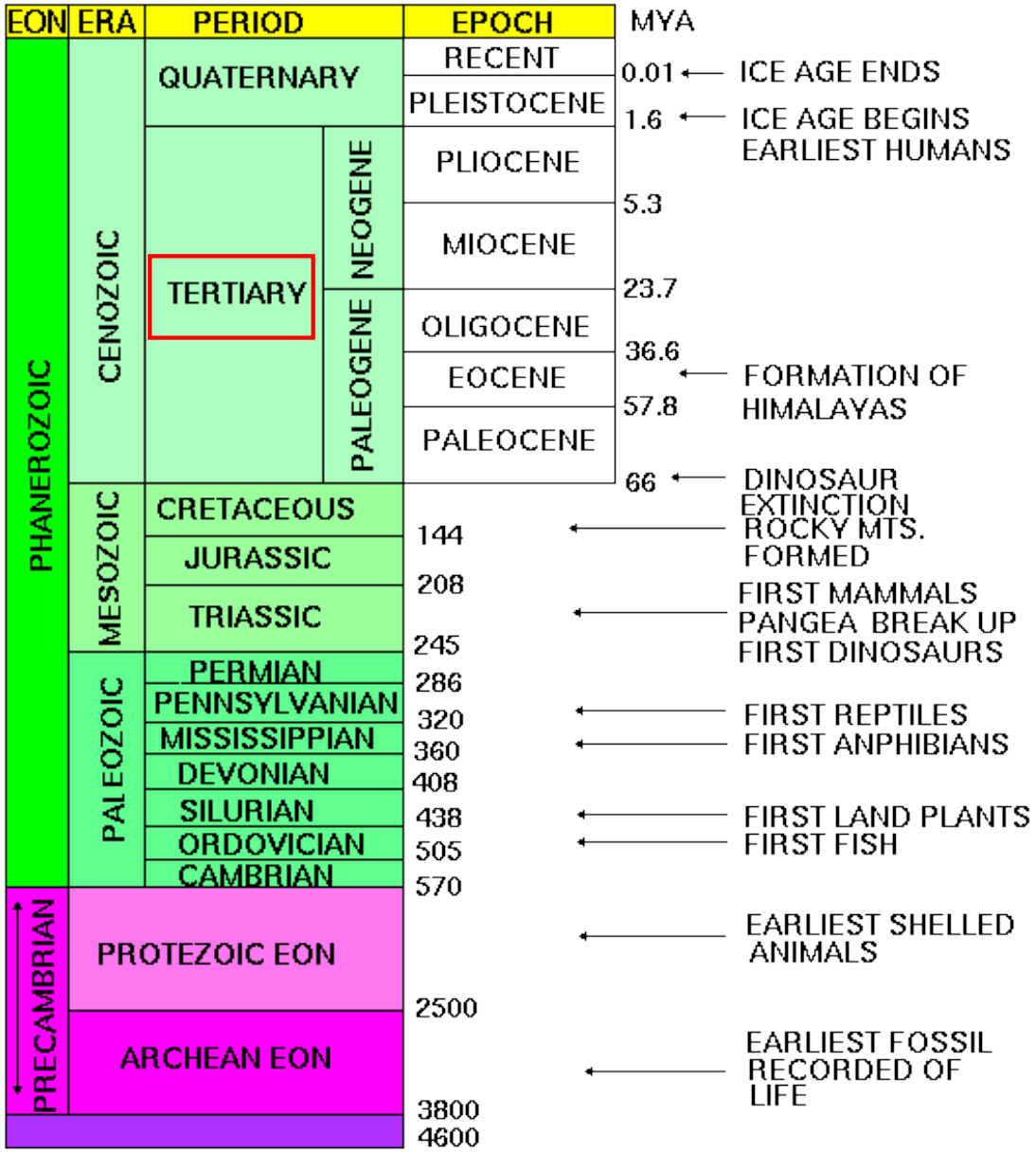
Stewartia malacodendron
Theaceae - tea family

Stewartia sinensis

Stewartia pseudocamellia

First disjunction recognized by botanical biogeographers and thus played an important role in Darwin's evidence for evolution

Eastern North America - Eastern Asia



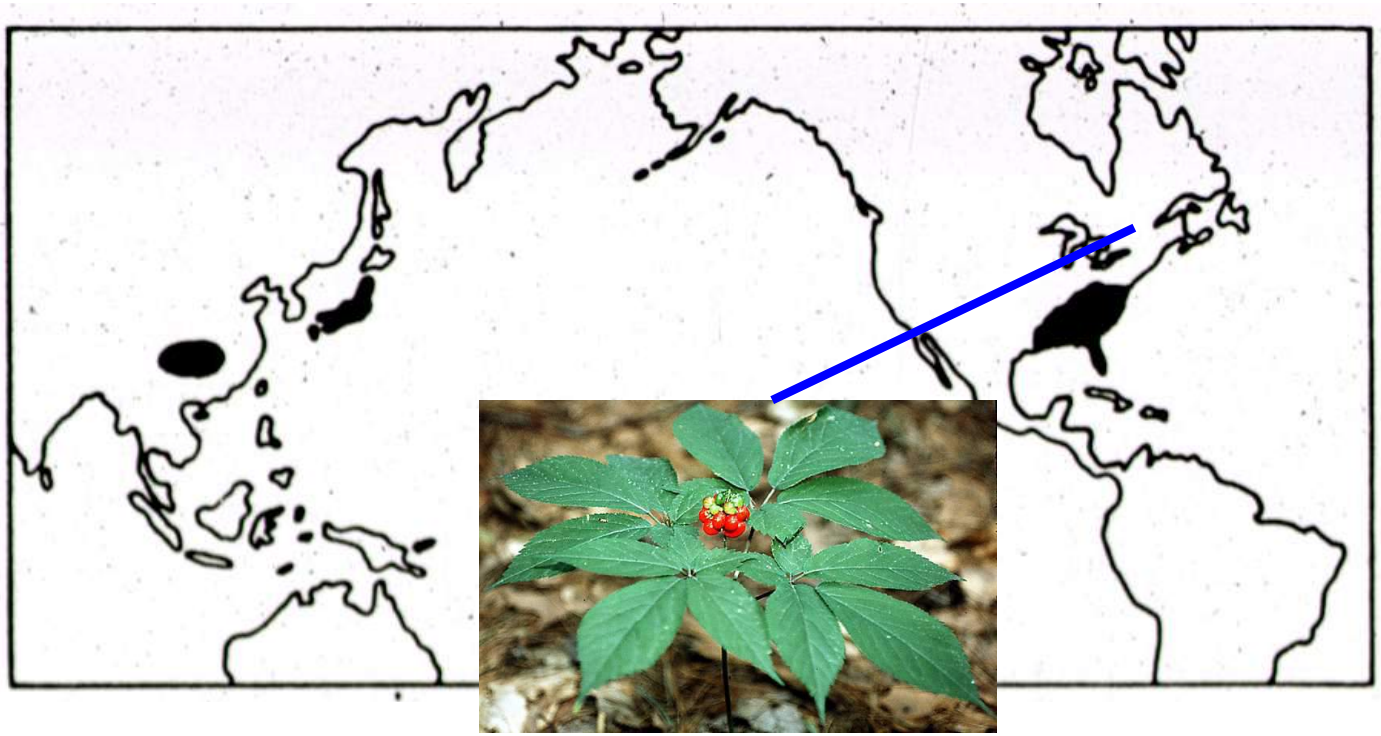
Pattern also involves fossil taxa from the Tertiary (back to about 40 mya), and thus has been termed the *Arcto-Tertiary Flora*

Miocene *Magnolia* fossils - Idaho

Eastern North America - Eastern Asia

Credit for the recognition of the floristic similarities often given to Asa Gray (Harvard University), but the first published reference was in a thesis by Linnaeus' student Jona Halenius (1750)

Pattern first noticed by a Jesuit priest, Father Joseph Lafitau, who found American ginseng (1716) near Montreal after reading description of the Chinese ginseng



Eastern North America - Eastern Asia

Four quick points (reviewed by Jun Wen)

Caulophyllum robustum

Jun Wen – Smithsonian Institute of Natural History

Eastern North America - Eastern Asia

1. Pattern originally thought to include "identical species" (Gray listed 134) but now all but one are congeneric not conspecific.

Caulophyllum robustum

Caulophyllum thalictroides
Blue cohosh - Berberidaceae

Eastern North America - Eastern Asia

1. Pattern originally thought to include "identical species" (Gray listed 134) but now all but one are congeneric not conspecific.

Mitchella undulata

Mitchella repens
Partridge-berry, Rubiaceae

Eastern North America - Eastern Asia

1. Pattern originally thought to include "identical species" (Gray listed 134) but now all but one are congeneric not conspecific.

Symplocarpus renifolius

Symplocarpus foetidus
Skunk cabbage, Araceae

Eastern North America - Eastern Asia

2. Up to 65 genera in 42 different families involved . . . including trees

Liriodendron chinense

Liriodendron tulipfera
Tulip tree, Magnoliaceae

1 sp. E. Asia vs. 1 sp. E. North America

Eastern North America - Eastern Asia

2. Up to 65 genera in 42 different families involved . . . including trees

Hamamelis mollis

Hamamelis virginiana
Witch hazel, Hamamelidaceae

2 spp. E. Asia vs. 2 spp. E. North America

Eastern North America - Eastern Asia

2. Up to 65 genera in 42 different families involved . . . including vines

Parthenocissus heneryana

Parthenocissus quinquefolia
Virgnia creeper, woodbine, Vitaceae

9 spp. E. Asia vs. 3 spp. E. North America

Eastern North America - Eastern Asia

2. Up to 65 genera in 42 different families involved . . . including vines

Campsis sp.

Campsis radicans
Trumpet creeper, Bignoniaceae

1 sp. E. Asia vs. 1 sp. E. North America

Eastern North America - Eastern Asia

2. Up to 65 genera in 42 different families involved . . . including herbs

Jeffersonia dubia

Jeffersonia diphylla
Twinleaf, Berberidaceae

1 sp. E. Asia vs. 1 sp. E. North America

Eastern North America - Eastern Asia

2. Up to 65 genera in 42 different families involved . . . including herbs

Podophyllum hexandra

Podophyllum peltatum
Mayapple, Berberidaceae

1 sp. E. Asia vs. 1 sp. E. North America

Eastern North America - Eastern Asia

2. Up to 65 genera in 42 different families involved . . . including herbs

Nelumbo nucifera

Nelumbo lutea
Lotus lily, Nelumbonaceae

1 sp. E. Asia vs. 1 sp. E. North America

Eastern North America - Eastern Asia

3. In few cases, the disjunction involves different but closely related genera

Eomecon chionantha

Sanguinaria canadensis
Bloodroot, Papaveraceae

Eastern North America - Eastern Asia

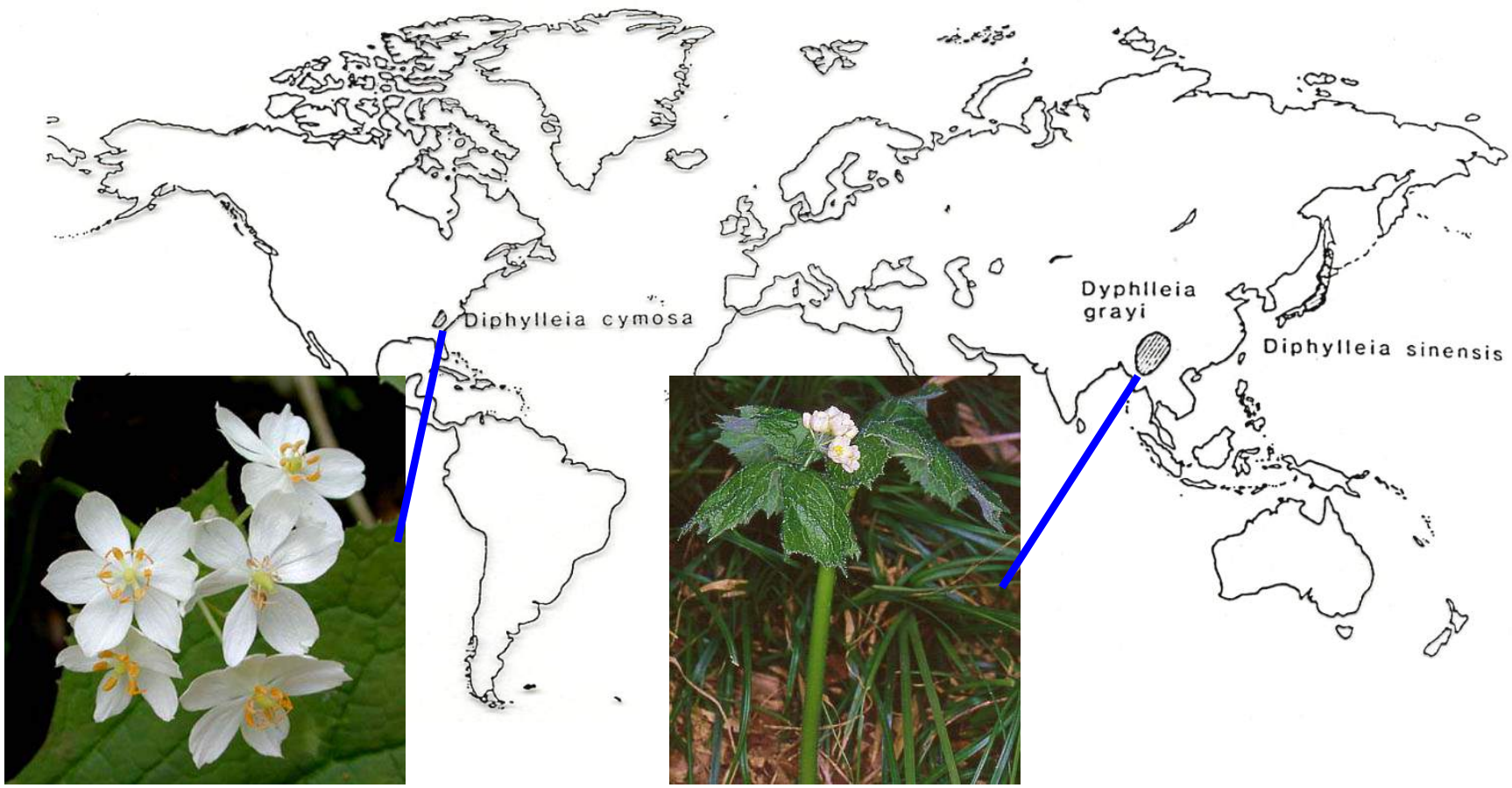
3. In few cases, the disjunction involves different but closely related genera

Weigela florida

Diervilla splendens
Bush honeysuckle, Caprifoliaceae

Eastern North America - Eastern Asia

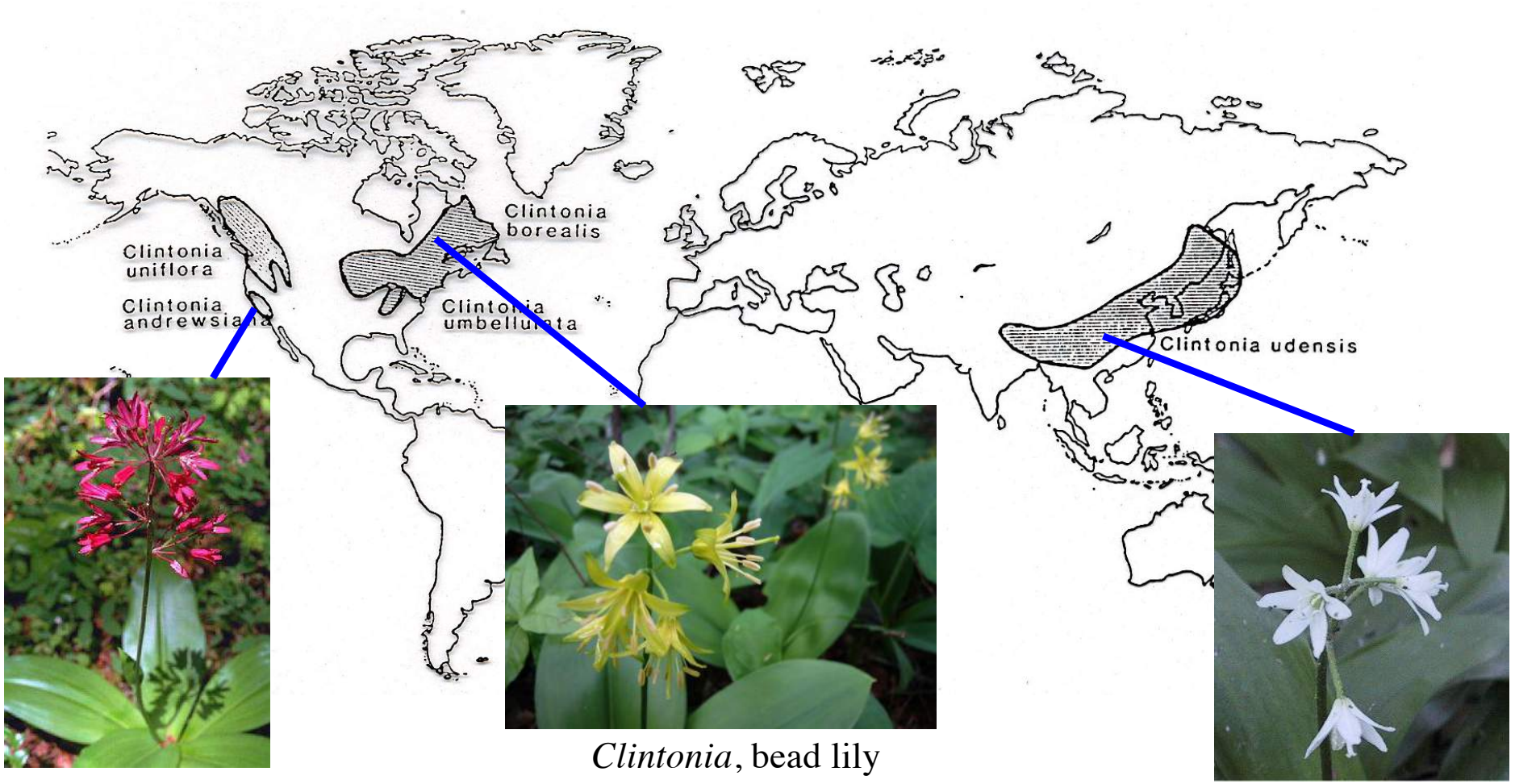
4. The disjunction typically involves E. North America and E. Asia . . .



4. The disjunction typically involves E. North America and E. Asia . . .

Eastern North America - Eastern Asia

4. . . . but can involve western North America . . .



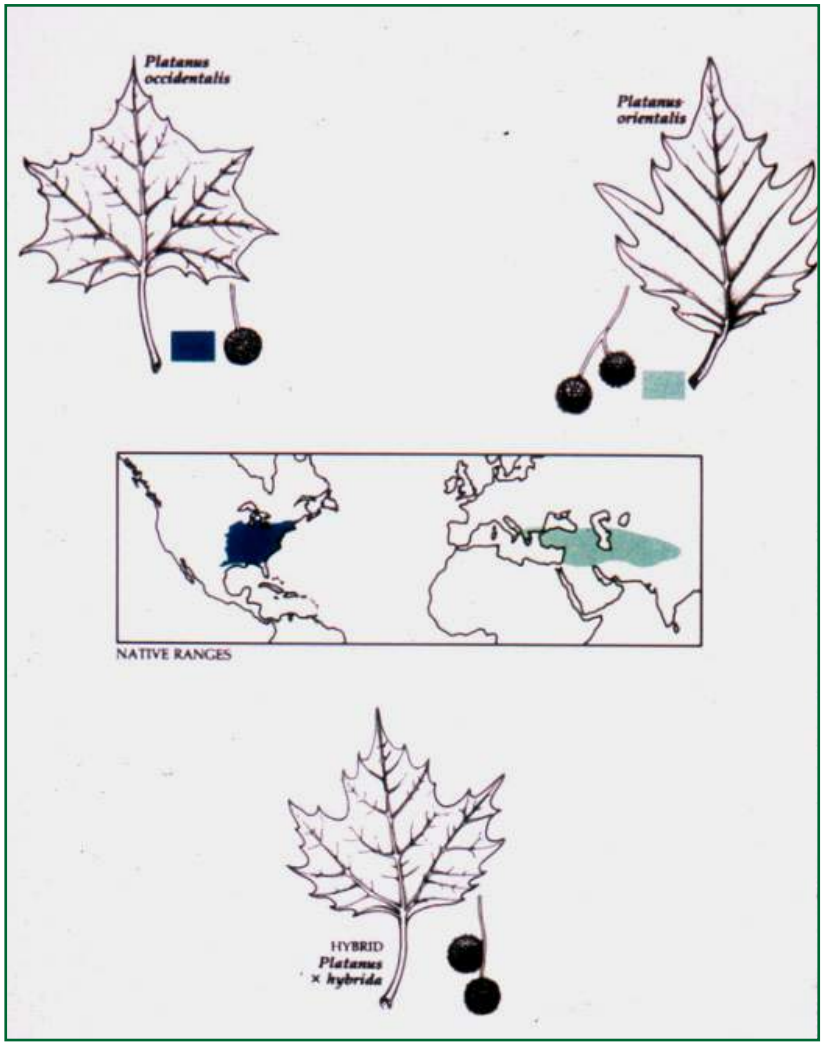
Clintonia, bead lily

4. . . . but can involve western North America . . .

Eastern North America - Eastern Asia

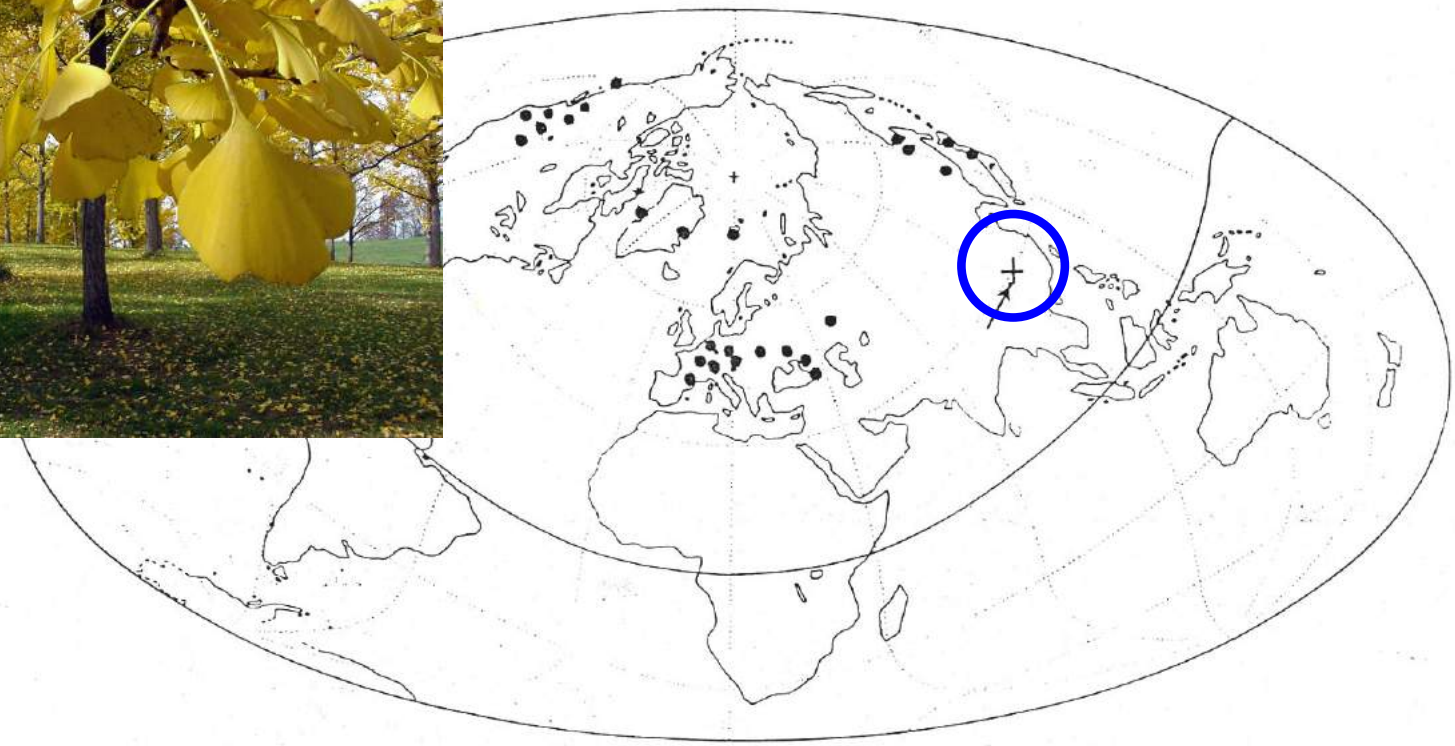
4. . . . and sometimes western Eurasia

The European plane tree is a hybrid between the eastern North American and central Asian sycamores - *Platanus* x *hybrida* - and is more tolerant to urbanization



Eastern North America - Eastern Asia

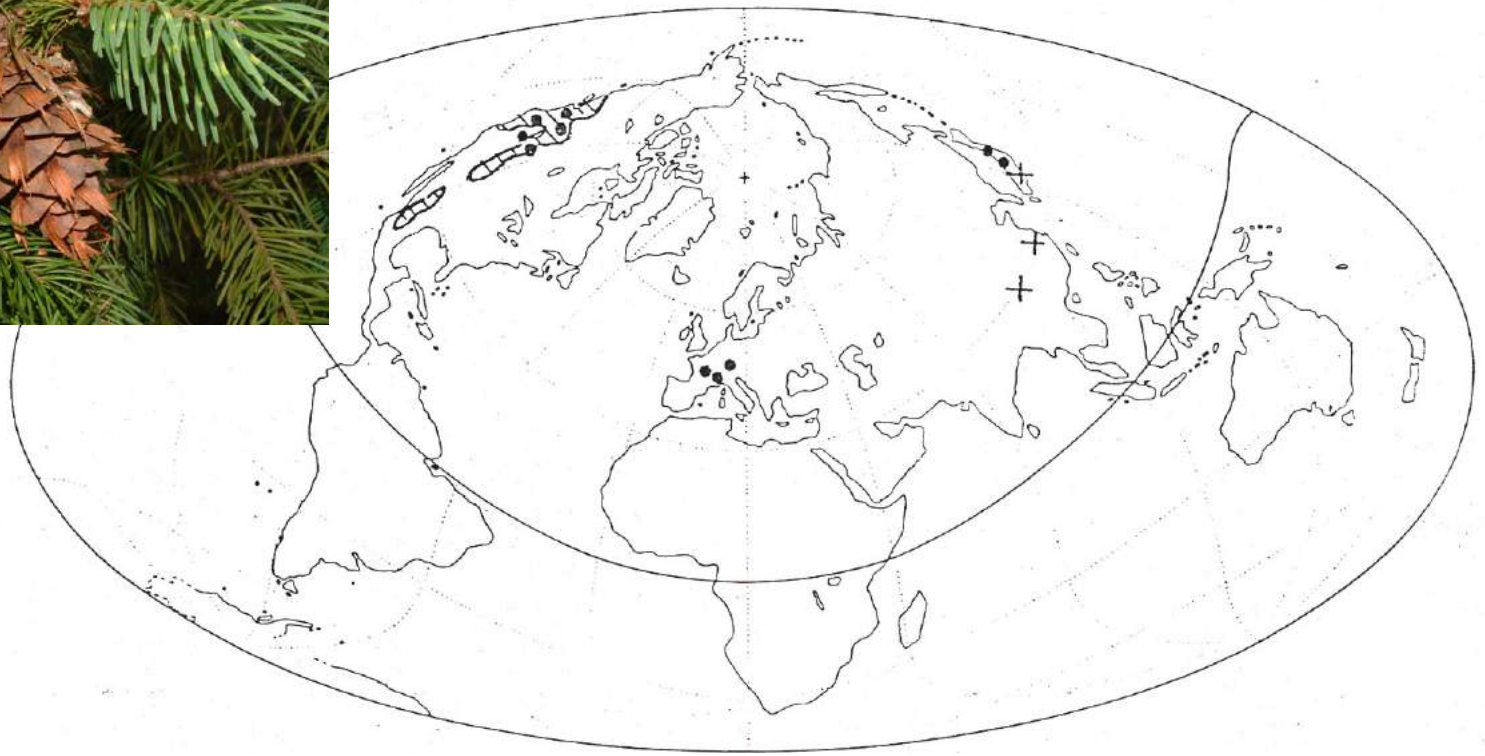
5. Fossil evidence indicates widespread Arcto-Tertiary Flora existed with subsequent extinction in parts of this range:



Ginkgo, now confined to east-central China, had a wide Holarctic distribution from the Paleocene into the Neogene as indicated by fossil localities (●)

Eastern North America - Eastern Asia

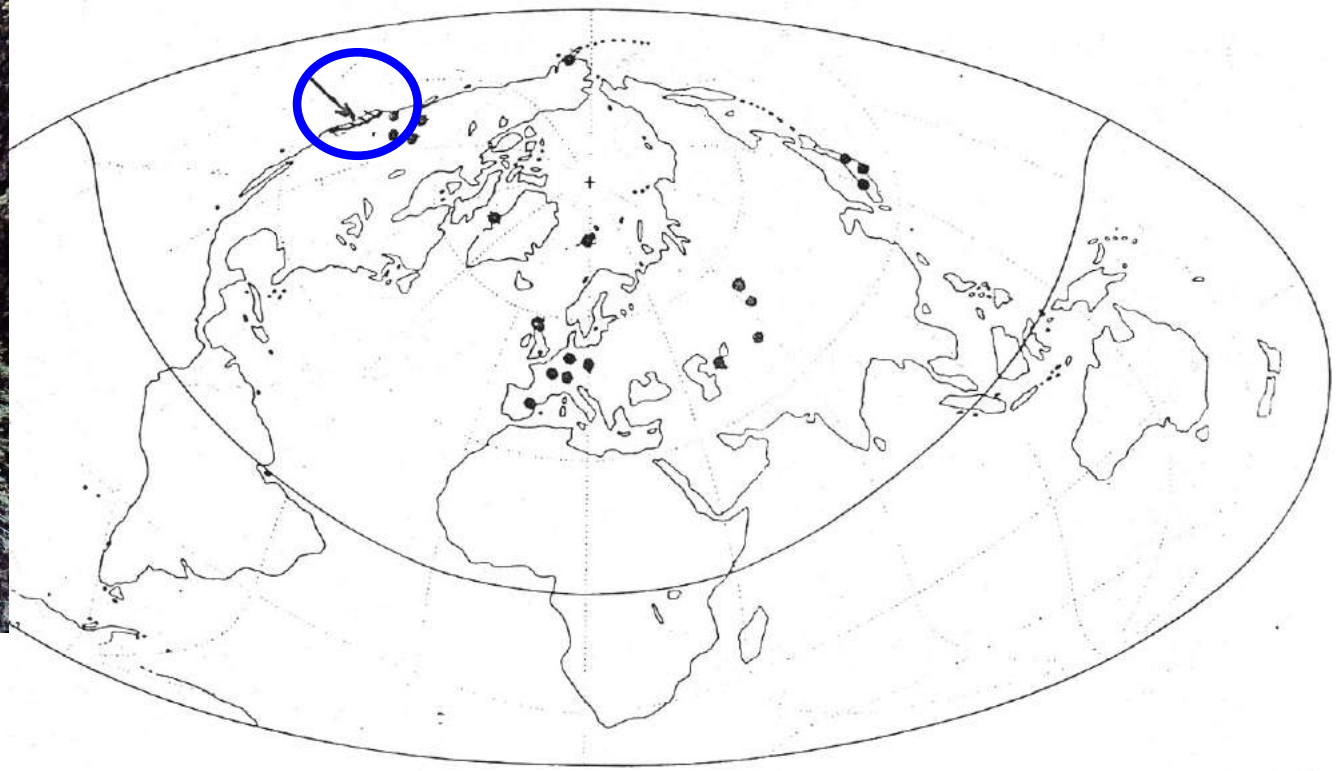
5. Fossil evidence indicates widespread Arcto-Tertiary Flora existed with subsequent extinction in parts of this range:



*Pseudotsuga (*Douglas fir*)* is widespread today in western North America but has only relictual stands (+) in eastern Asia. Fossil localities (●) indicate its wider distribution in the past.

Eastern North America - Eastern Asia

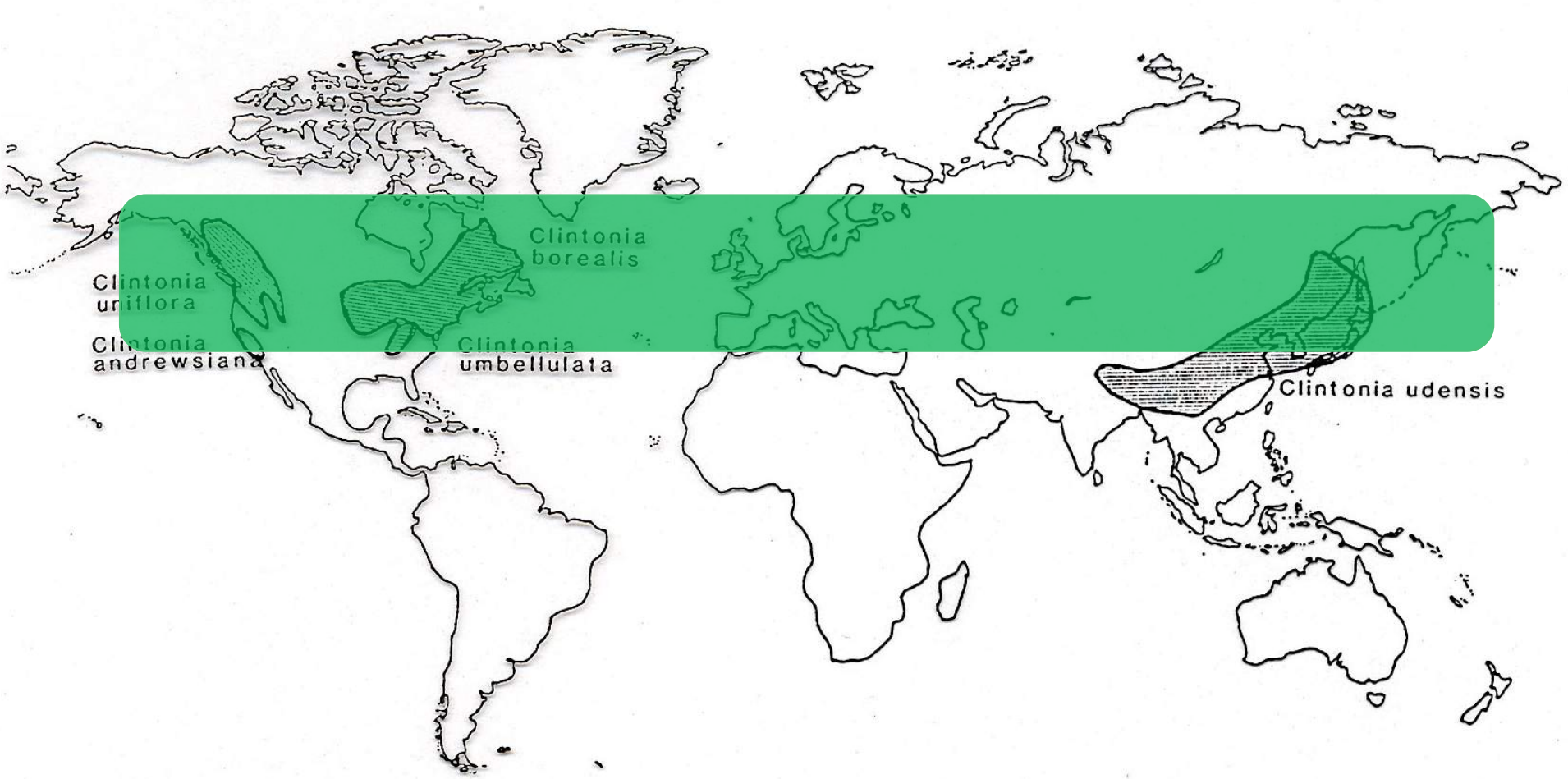
5. Fossil evidence indicates widespread Arcto-Tertiary Flora existed with subsequent extinction in parts of this range:



Sequoia, now confined to coastal California and adjacent Oregon, had a Holarctic Tertiary distribution as indicated by some of its fossil sites (●).

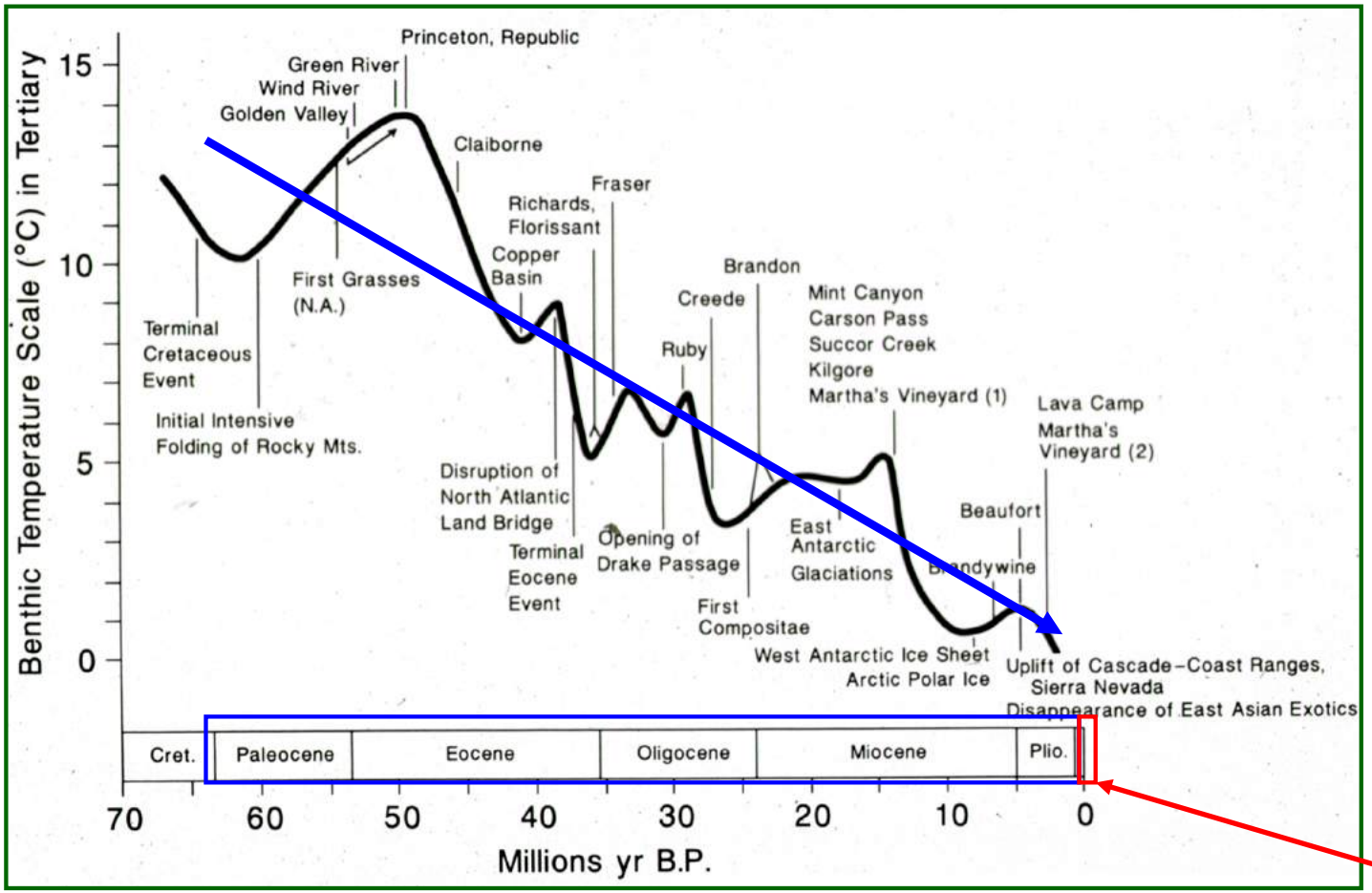
Eastern North America - Eastern Asia

Summary: widespread Arcto-Tertiary Flora followed by geological and climatic sundering – vicariance assumed



Eastern North America - Eastern Asia

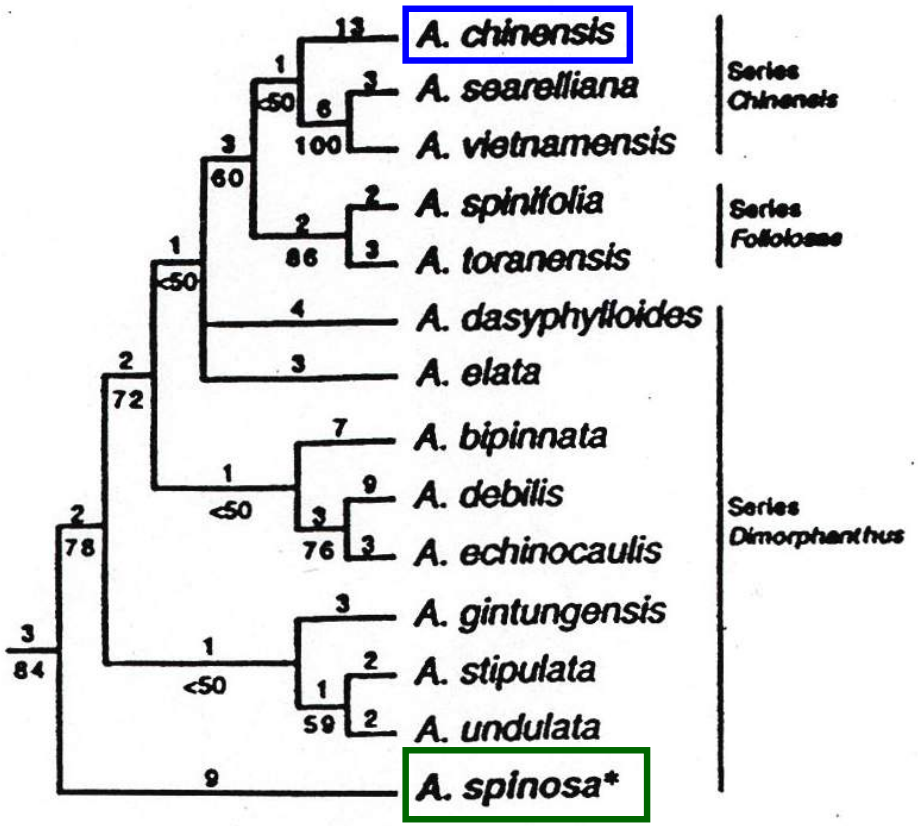
Worldwide cooling during the Tertiary and culminated in the Pleistocene glaciations



Quaternary —
Pleistocene + Holocene

Eastern North America - Eastern Asia

New Twists! — Phylogenetic analyses of 11 putative pairs of vicariad species - *are they sister species?*

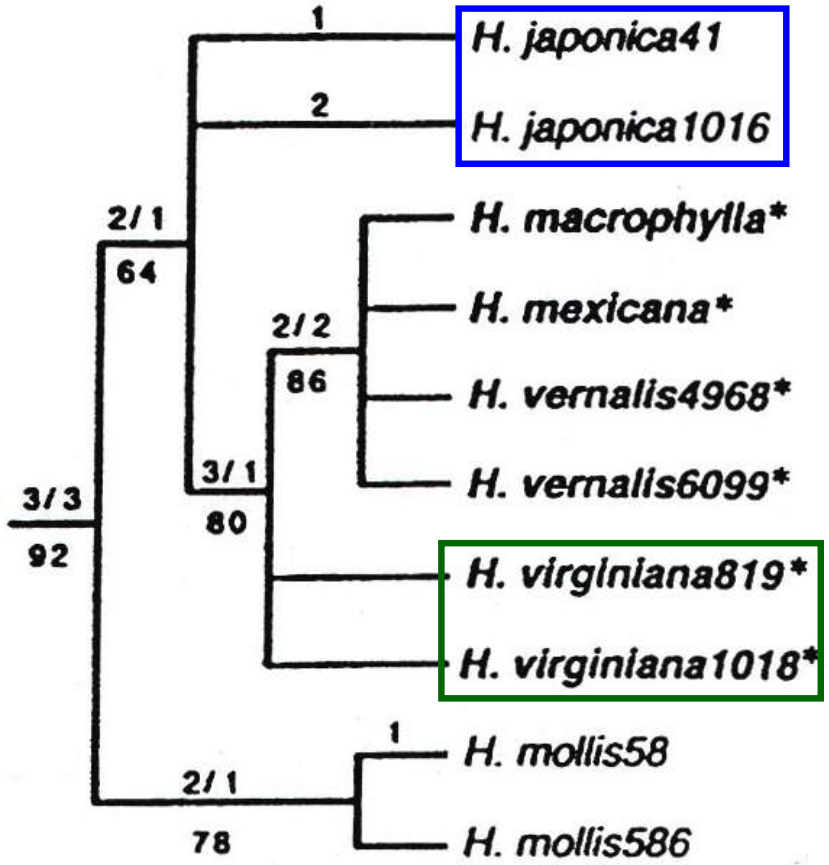


Aralia — NO

Aralia spinosa
Devil's walking stick, Araliaceae

Eastern North America - Eastern Asia

New Twists! — Phylogenetic analyses of 11 putative pairs of vicariad species - *are they sister species?*

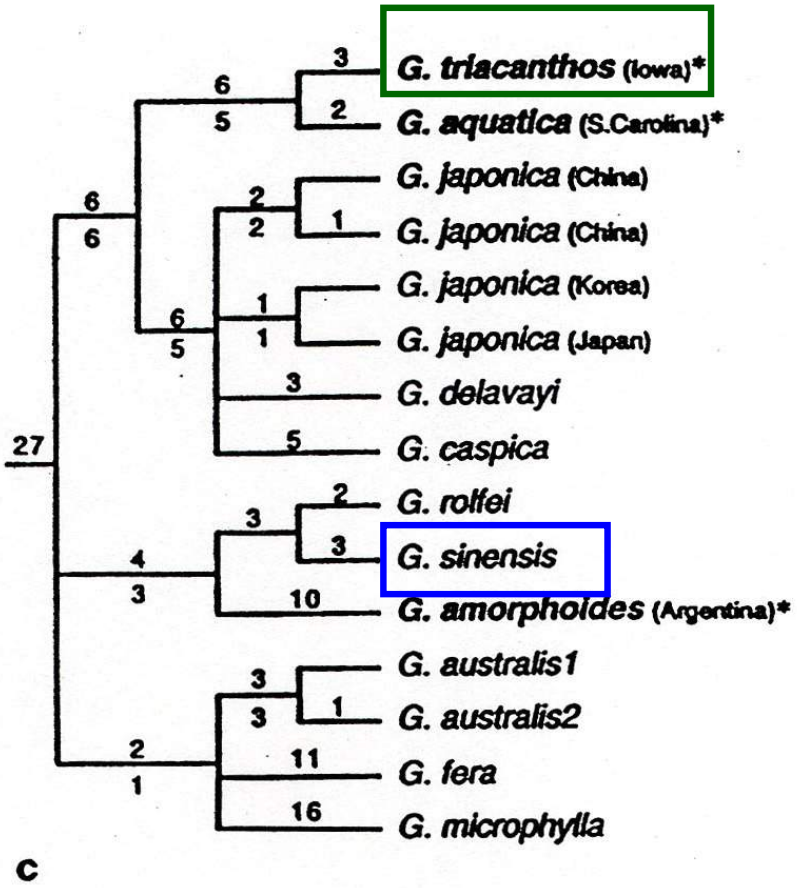


Hamamelis — NO

Hamamelis
Witch hazel, Hamamelidaceae

Eastern North America - Eastern Asia

New Twists! — Phylogenetic analyses of 11 putative pairs of vicariad species - *are they sister species?*



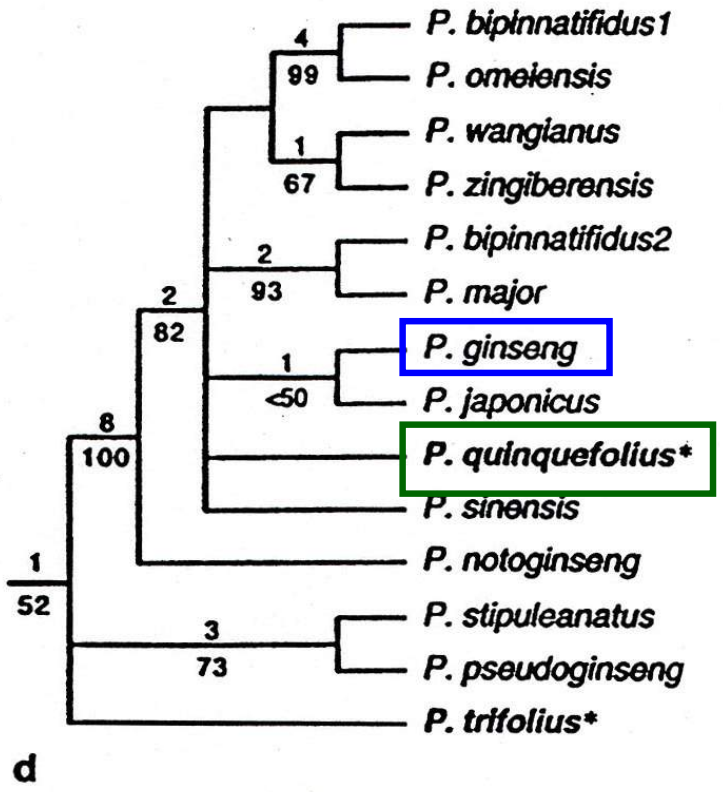
Gledistsia — NO

Gleditsia
Honey locust, Fabaceae

Eastern North America - Eastern Asia

New Twists! — Phylogenetic analyses of 11 putative pairs of vicariad species - *are they sister species?*

Panax — NO

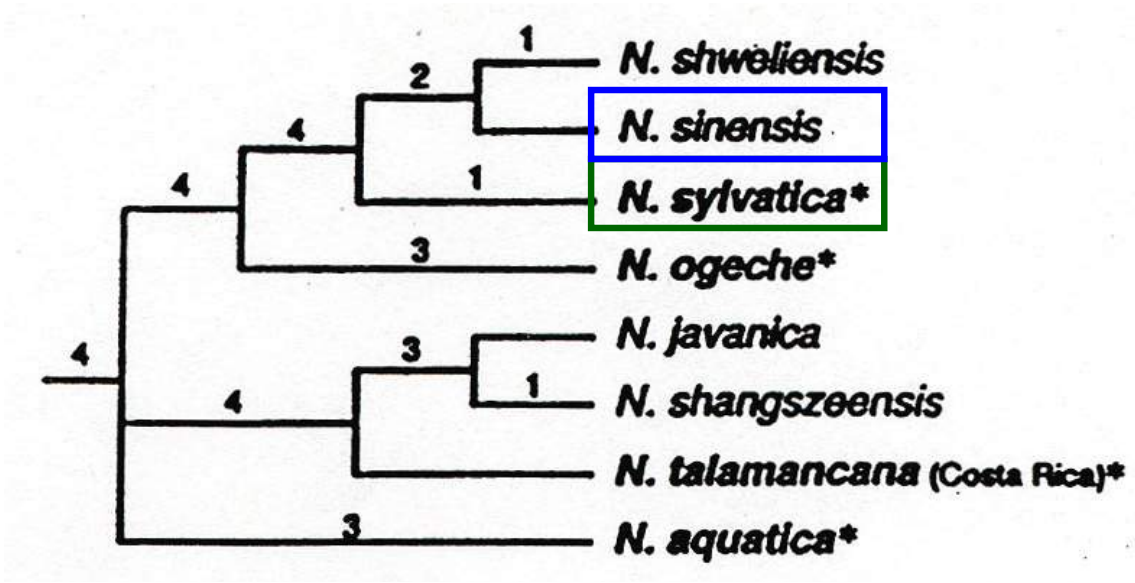


Panax quinquefolius
American ginseng, Araliaceae

Eastern North America - Eastern Asia

New Twists! — Phylogenetic analyses of 11 putative pairs of vicariad species - *are they sister species?*

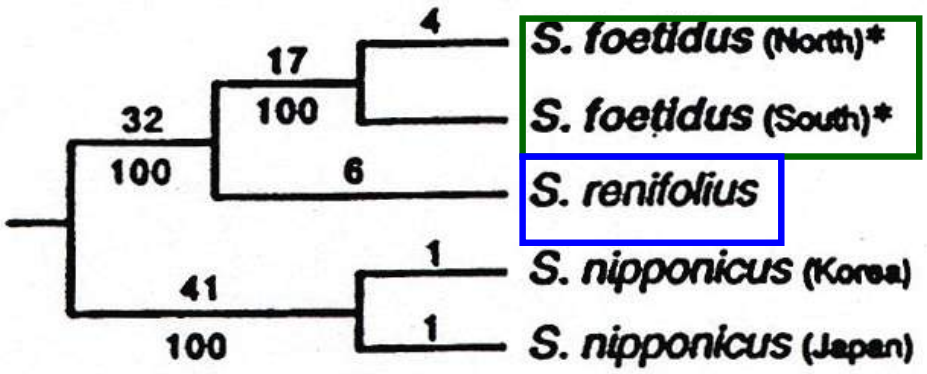
Nyssa — +/-



Nyssa sylvatica - sour gum, black gum,black tupelo

Eastern North America - Eastern Asia

New Twists! — Phylogenetic analyses of 11 putative pairs of vicariad species - *are they sister species?*



Symplocarpus — YES

Symplocarpus foetidus, skunk cabbage

Symplocarpus renifolius

Eastern North America - Eastern Asia

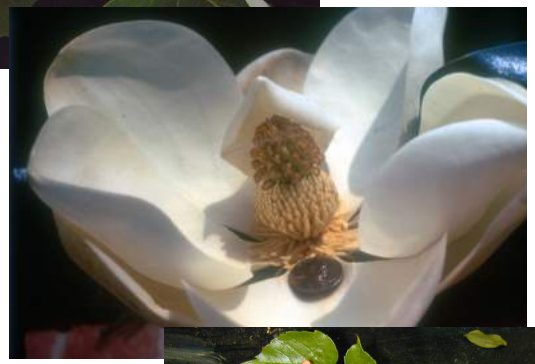
New Twists! — *when did the species diverge? AND are ages consistent with single vicariance event?*

1. *Liriodendron* - tulip trees

   13 mya

2. *Magnolia* - magnolias

   2 mya

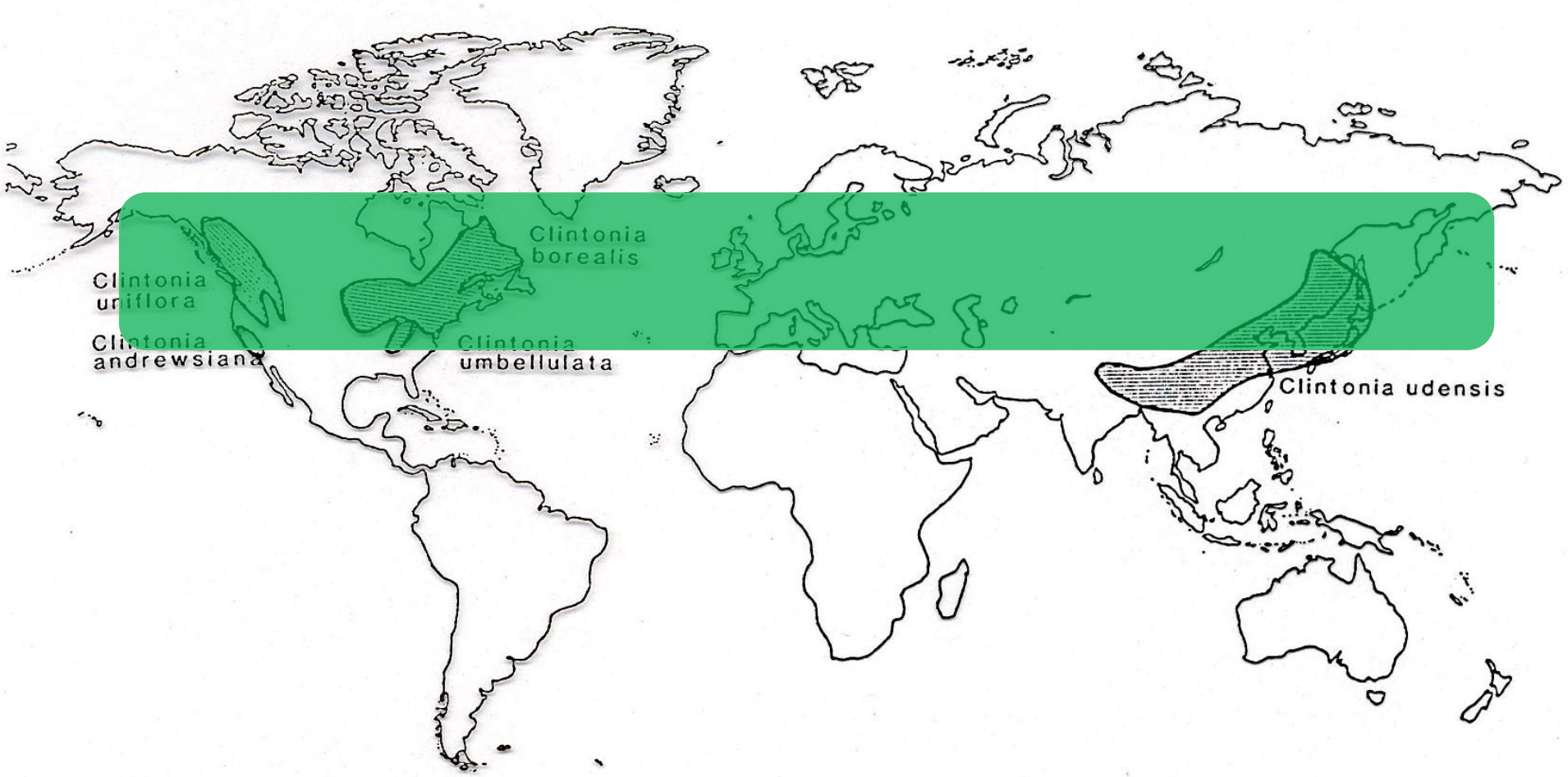


3. *Campsis* - trumpet creepers

   25 mya

Eastern North America - Eastern Asia

Summary: Species relationships & Molecular clocks - *do not support classical idea of vicariance !*



Eastern North America - Eastern Asia

Flora vs Faunal Patterns: new insights

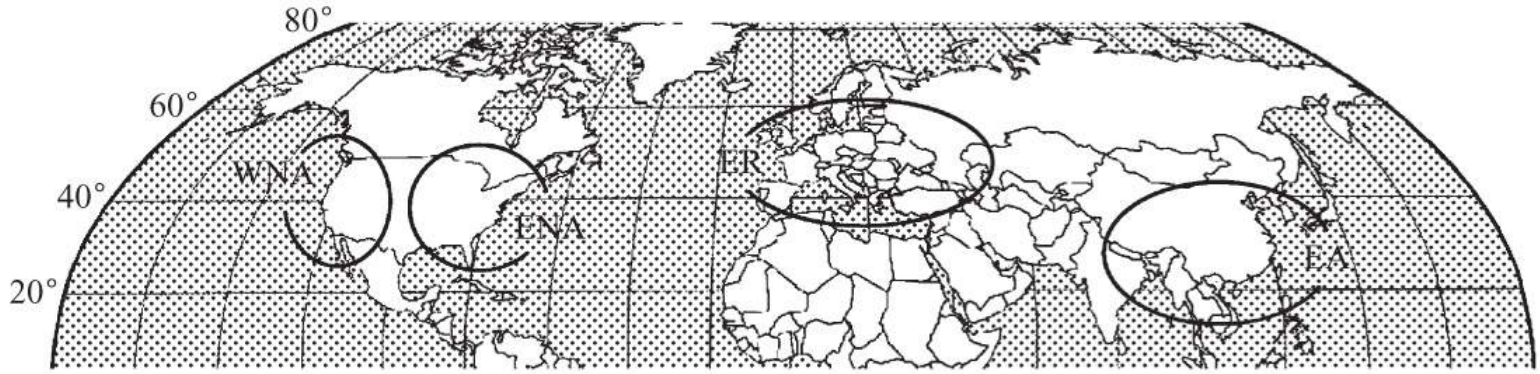


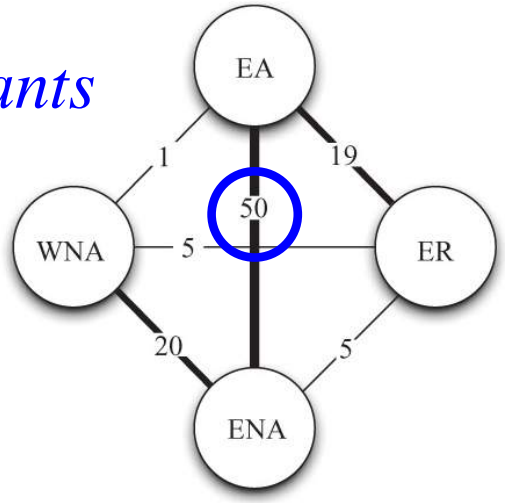
Figure 1. Map of the Northern Hemisphere showing the four major areas of temperate forest endemism that are the focus of the present analysis; EA: eastern Asia; ER: Europe (including southwestern Asia); ENA: eastern North America; WNA: western North America.

Meta-analysis of 100 examples of disjunctions (33 with absolute time divergences) among these four areas

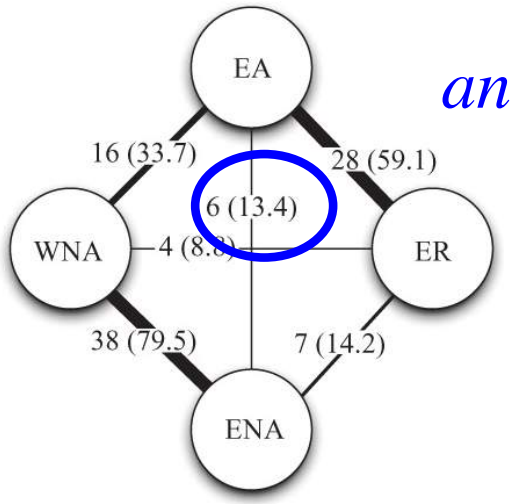
Eastern North America - Eastern Asia

Flora vs Faunal Patterns: new insights

plants



animals



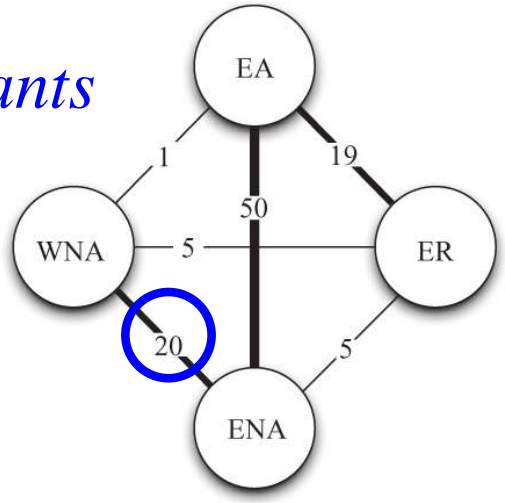
% of examples showing various disjunct patterns

1. Plants show considerably *higher* proportion of Eastern Asia - Eastern North America disjunct pattern than do animals

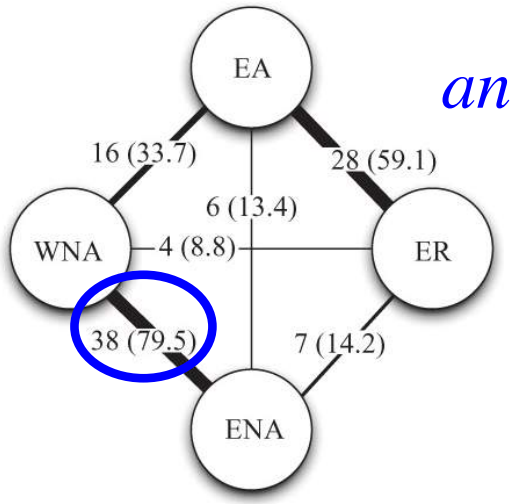
Eastern North America - Eastern Asia

Flora vs Faunal Patterns: new insights

plants



animals



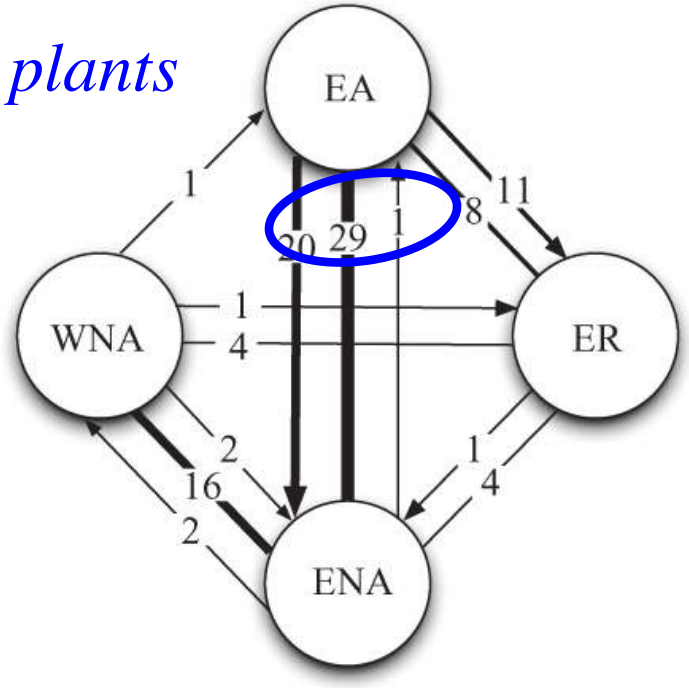
% of examples showing various disjunct patterns

2. Plants show considerably *lower* proportion of Western North America - Eastern North America disjunct pattern than do animals

Eastern North America - Eastern Asia

Flora vs Faunal Patterns: new insights

plants



Arrows indicate inferred directions of dispersal

3. Eastern Asia is source of 20 of the disjuncts, and Eastern North America only 1. These dispersal events occurred over the last 30 my and with Beringia the likely route.