COMPARISON OF [illegible] AND NORTH AMERICAN VELVET [illegible] MICRY COMPLEXES

By Holly Bootle

GOAL OF THE PAPER:

To find out if African velvet ant mu¨llerian mimicry rings exist, and how do they compare to the North American complex. They then explore what factors might contribute to the differences in mimetic diversity between continents.

The depauperate nature of the African tropical fauna and flora has led some to call Africa the “odd man out.” One exception to this pattern is velvet ants, wingless wasps that are known for mu ̈llerian mimicry. While North American velvet ants form one of the world’s largest mimicry complexes, mimicry in African species has not yet been investigated.

- Mimicry is an evolved resemblance between an organism and another object. It often functions to protect a species from predators.

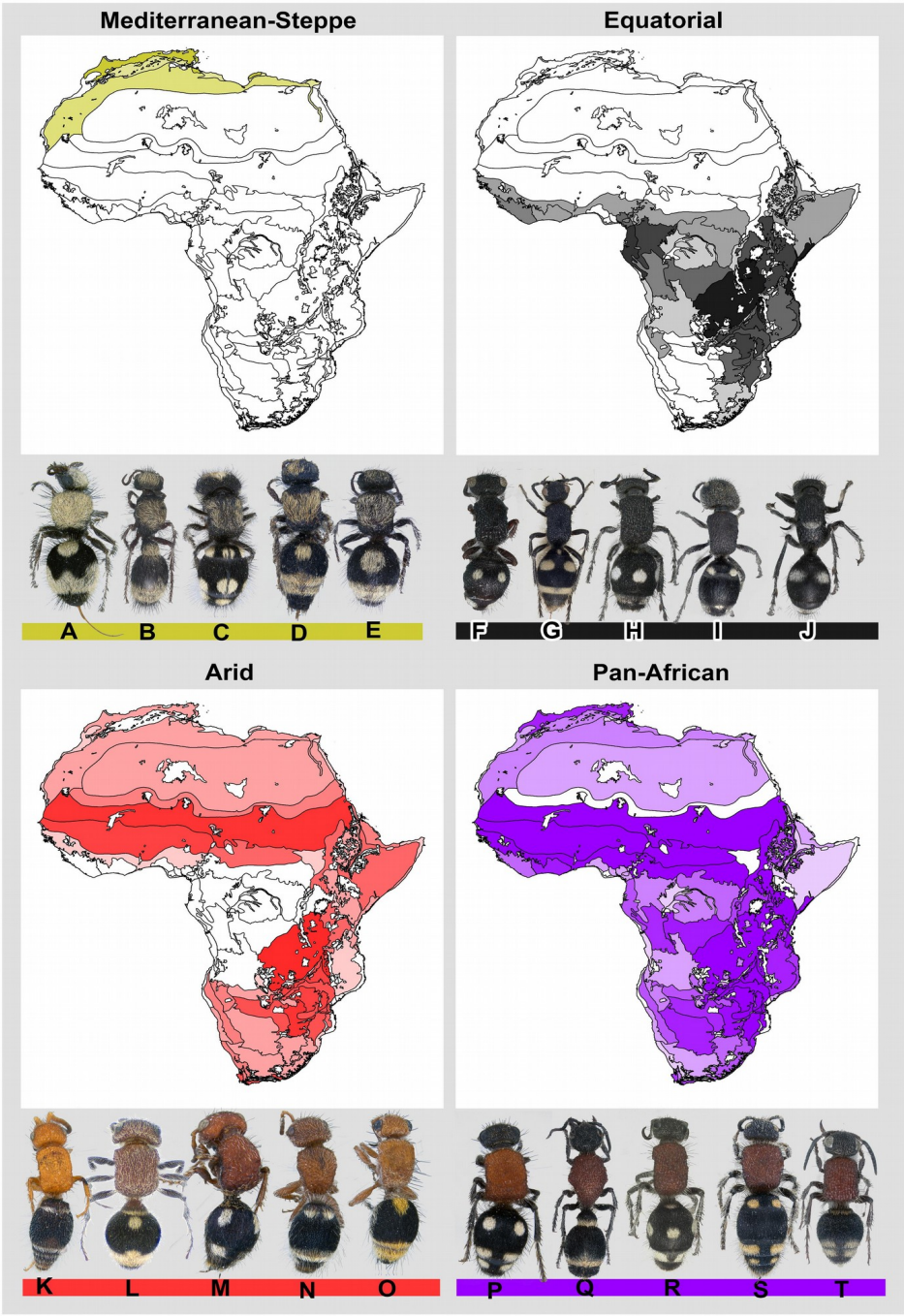
- Three types of defensive mimicry:
1. Batesian Mimicry
2. Mertensian Mimicry
3. Mullerian Mimicry

- Once a pair of Müllerian mimics has formed, other mimics may join them by advergent evolution forming mimicry rings.

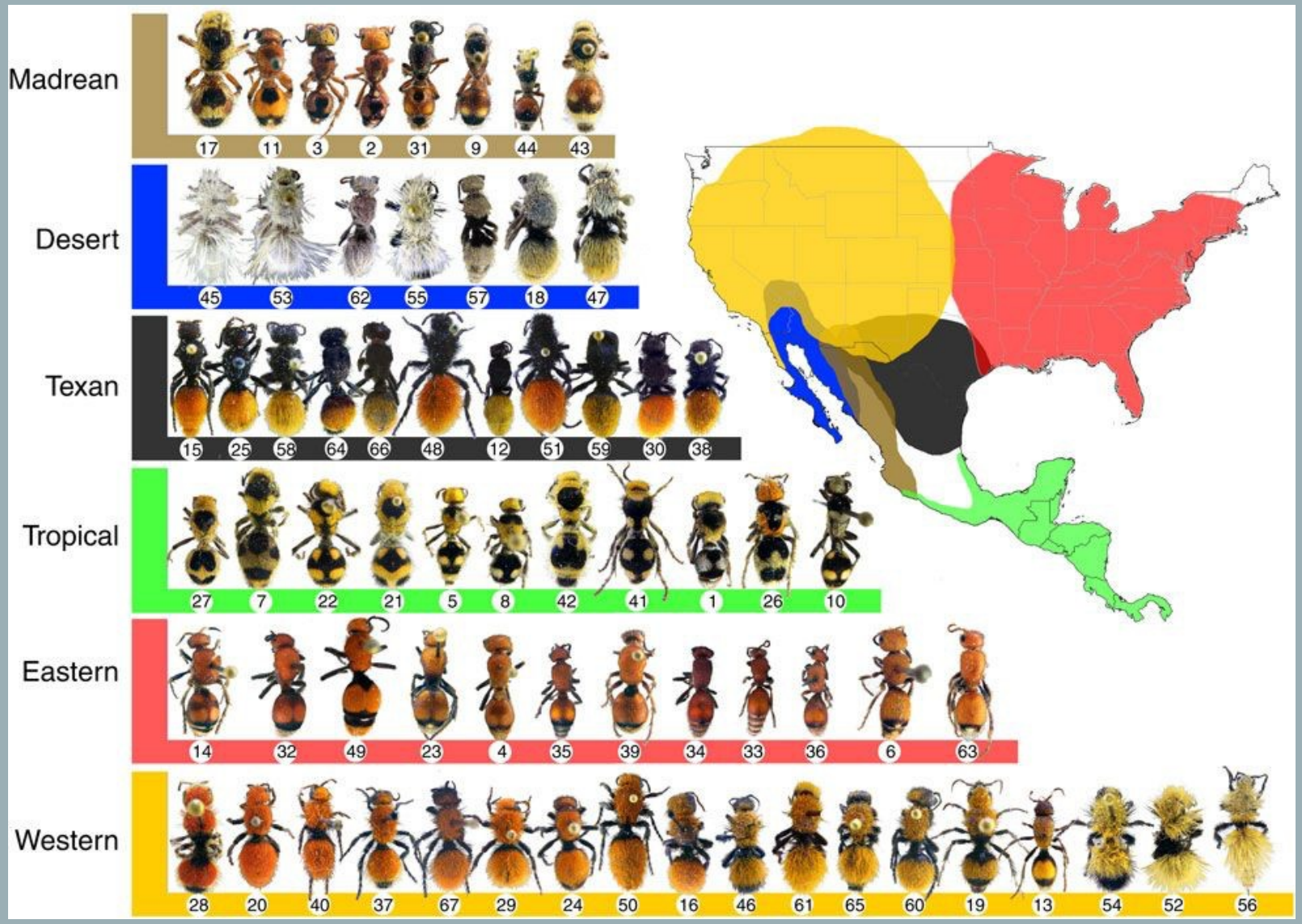
METHODS:

- Specimen sampling
- Morphological analysis
- Distributional analysis
- Analysis of predator richness
- Analysis of ecoregion diversity

RESULTS



This is the morphological and geographic ranges of the four African velvet ant mimicry rings. Each mimicry ring is represented here by five species.



A total of 65 are placed into six mimicry rings that are defined by shared color, pattern and geographic location.

BIOGEOGRAPHY OF *COPTIS SALISBURY*, AN EASTERN ASIAN AND NORTH AMERICAN GENUS

GOAL OF THE PAPER:

To determine how *Coptis was* disjunctly distributed in North America, Japan, mainland China, and Taiwan by presenting a dated phylogeny and infer its historical biogeography by comparing different biogeographic models.

Coptis is a genus of between 10–15 species of flowering plants in the family Ranunculaceae, native to Asia and North America. The goldthread genus *Coptis Salisb.* is mainly distributed in the warm temperate to the cold coniferous forests of eastern Asia and North America. The split of *Coptis* and *Xanthorhiza* occurred in the middle Miocene period.

Coptis

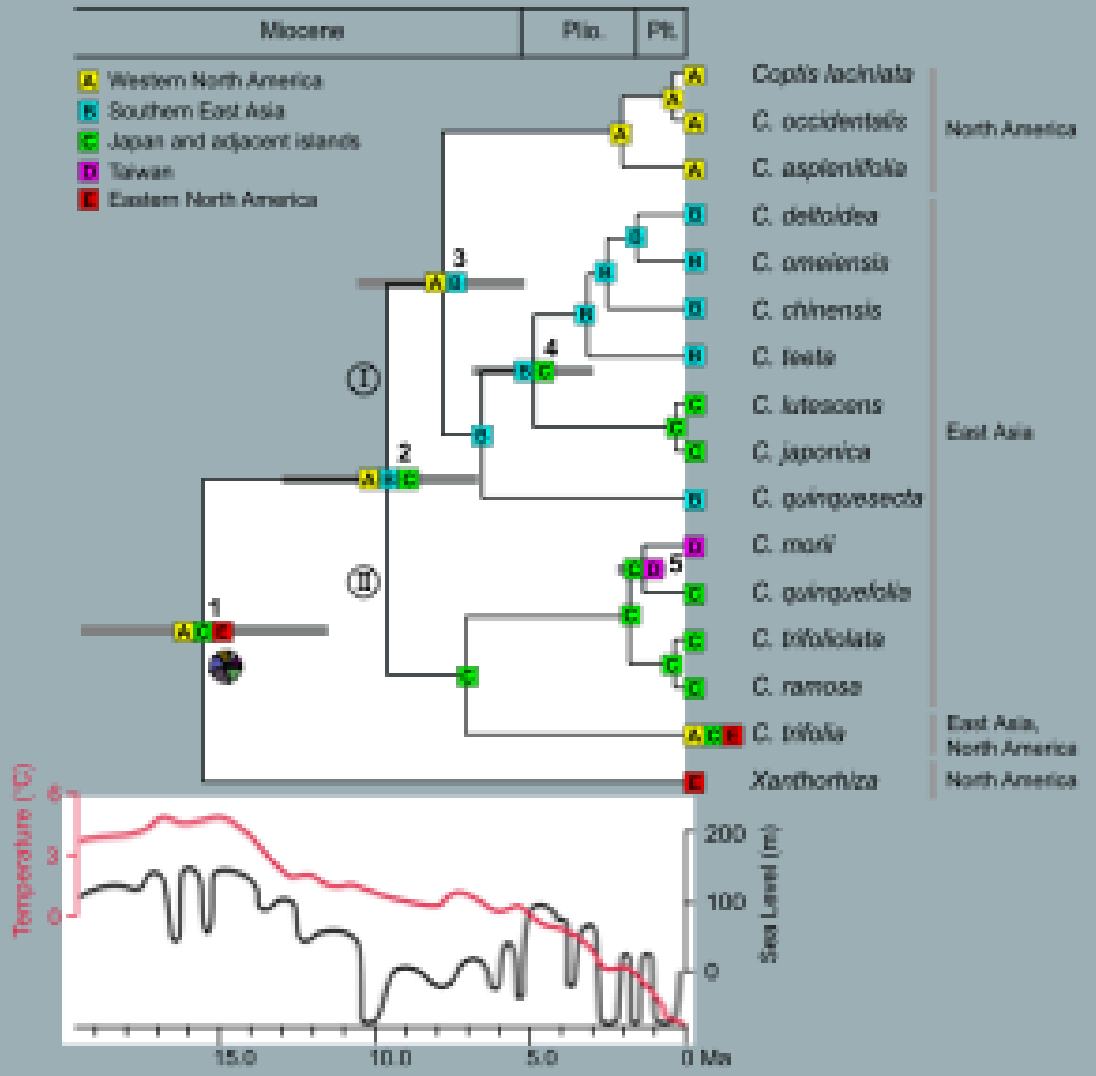
Xanthorhiza

METHODS:

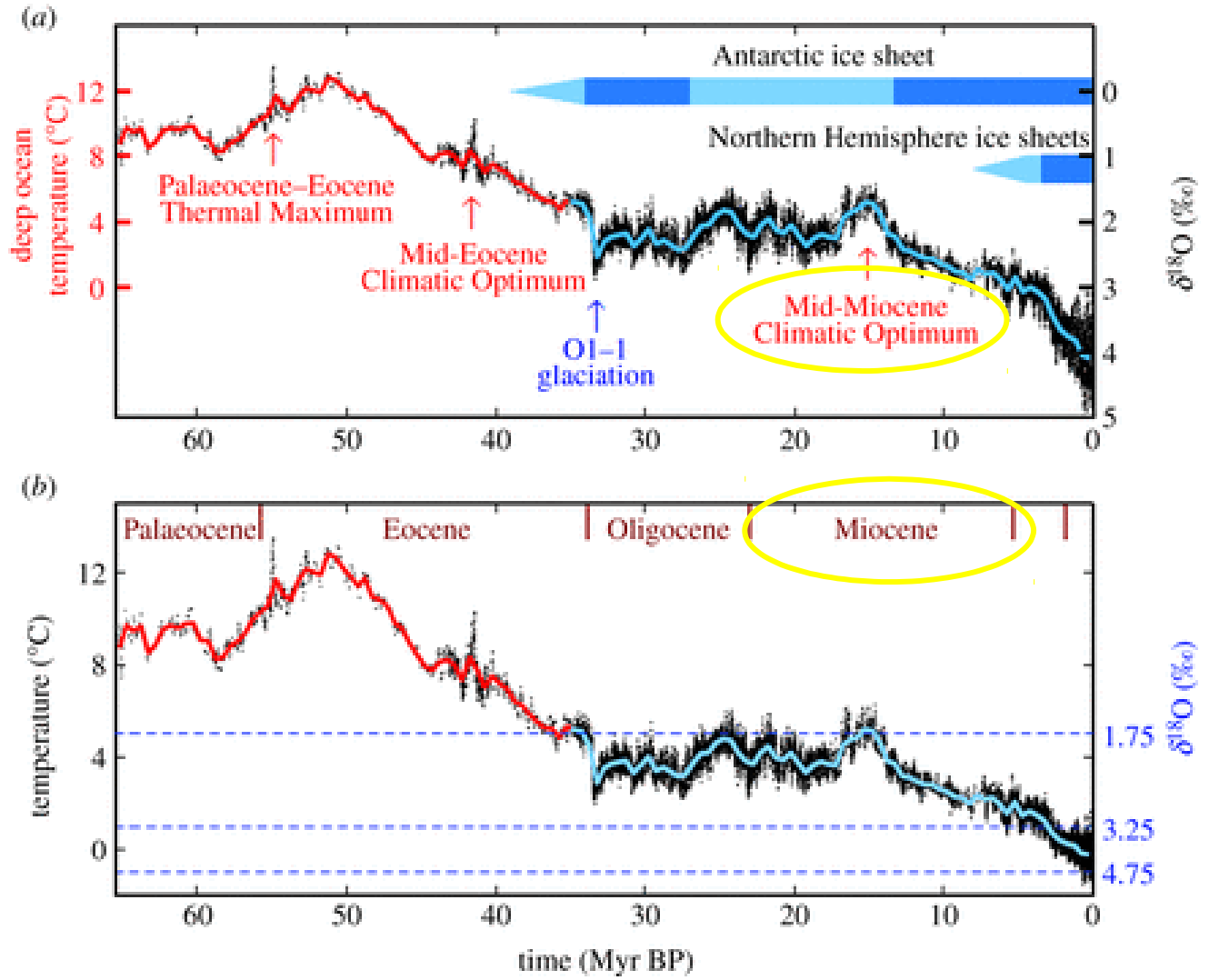
- Samples

- Ancestral range analysis

RESULTS


Miocene
Plio.
Plt.
A Western North America
B Southern East Asia
C Japan and adjacent islands
D Taiwan
E Eastern North America
Copts lachnata
C. occidentalis
C. aspleniifolia
C. delavayi
C. omeiensis
C. chinensis
C. teeta
C. luteacens
C. japonica
C. quinquesecta
C. mairei
C. quinquefolia
C. trifoliolata
C. ramosa
C. trifolia
Xanthorhiza
North America
East Asia
East Asia, North America
North America
1
2
3
4
5
I
II
Temperature (°C)
6
3
0
200
100
0
Sea Level (m)
15.0
10.0
5.0
0 Ma

MMCO


(a)
Antarctic ice sheet
Northern Hemisphere ice sheets
deep ocean temperature (°C)
12
8
4
0
Palaeocene–Eocene Thermal Maximum
Mid-Eocene Climatic Optimum
Oi–1 glaciation
Mid-Miocene Climatic Optimum
0
1
2
3
4
5
δ18O (‰)
60
50
40
30
20
10
0
(b)
Palaeocene
Eocene
Oligocene
Miocene
temperature (°C)
12
8
4
0
1.75
3.25
4.75
δ18O (‰)
60
50
40
30
20
10
0
time (Myr BP)

Joseph S. Wilson[1☯]*, Aaron D. Pan[2,3☯]*, Erica S. Limb[1], Kevin A. Williams[4]

Müllerian mimicry, a form of biological resemblance in which two or more unrelated dangerous, organisms exhibit closely similar warning systems, such as the same pattern of bright colors.

The African velvet ant fauna includes almost a third of the family's species and subspecies.

If multiple mimetic rings do occur in Africa, it would be expected that the number of mimetic rings making up this complex would be more phenotypically diverse compared to those found in North America, given the greater geographic area and higher velvet ant species richness in Africa. Alternatively, the generally depauperate nature of the African fauna and flora could be reflected in a less diverse African mimetic complex than in North America.

We predict that the African velvet ants, while species rich and diverse, will have a less diverse mimicry complex compared to mimicry complexes from areas with a more diverse/heterogeneous predator fauna and/or a higher number of distinct ecological communities.

To test this hypothesis, they assessed the color pattern and distributions of 304 diurnal velvet ant taxa, 30% of the described species known from the African continent.

We ask:

(1) do African female velvet ant Mu¨llerian mimicry rings exist

(2) are the number of African mimetic rings comparable to the number of rings in North America

(3) is the familial diversity and species richness of insectivorous/omnivorous squamates, particularly iguanians, between both continental faunas related to the mimetic diversity of velvet ants, and

(4) is the number of terrestrial ecoregions and landmass sizes of both continents related to the mimetic diversity of velvet ants?

Methods

- ### Specimen sampling

Female African velvet ant specimens were photographed in dorsal and lateral views.

- ### Morphological analysis

This was to determine if the velvet ant species occurred in discrete groupings.

- **Distributional analysis**

Distributions of the velvet ant species were derived from specimen label locality data.

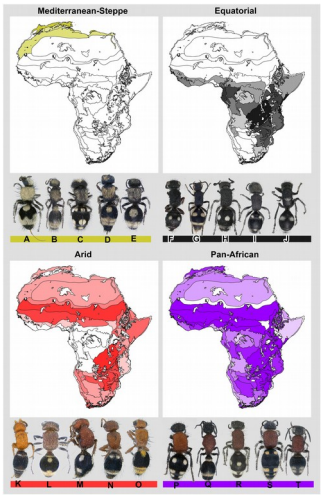
- **Analysis of predator richness**

Information on lizard familial diversity and species richness for Africa and North America was obtained from publications and reptile databases, and were compared.

- **Analysis of ecoregion diversity**

They compared the number of terrestrial ecoregions of the two areas.

Results



These species were selected because they are morphologically closest to the estimated mean for each mimicry ring. The geographic range of each mimicry ring is presented based on distributional analyses that examined the known range of each species involved in each mimicry ring.

- **Conclusion**

The study of mimicry in African velvet ants clearly shows that African velvet ants do participate in a large Mu¨llerian mimicry complex. Furthermore, we find that, while four distinct mimicry rings are found in Africa, this is less than the number of mimicry rings found in North America, further illustrating the “odd man out” concept of African species richness (in this case mimetic richness). We suggest that the lower number of African mimicry rings could be related to the diversity and distributions of lizards, with Africa having more uniform distribution of lizard species compared to North Americas lizard diversity that is concentrated in a few ecoregions. Finally, we suggest that the lower number of African mimicry rings is likely associated with the lower number of ecoregions in Africa compared to North America.

Andrey S. Erst[3,4], Florian Jabbour

Coptis seeds lack adaptation to wind-dispersal. Seeds are thereby not expected to disperse over long distance or oceanic barriers. Thus, *Coptis* provides a remarkable opportunity for studying the eastern Asian and western North American distribution pattern, as well as the biogeographic relationships within East Asia.

In this study, first a dated phylogeny for Coptis based on six DNA markers was reconstructed, using a Bayesian relaxed clock method. Using the resulting dated-phylogenetic framework, they then inferred the ancestral range evolution of *Coptis* by comparing the relative fit of six biogeographic models.

Methods

- **Samples**

They sampled all 15 species of *Coptis*.

- **Ancestral range analysis**

Based on the floristic characteristics and distributions of Coptis and Xanthorhiza, they coded five biogeographical areas: (A) western North America, (B) southern East Asia, (C) Japan and adjacent islands, (D) Taiwan, and (E) eastern North America. The maximum range size was set to three, as no surviving species occurs in more than three biogeographical regions.

Results

This ancestral range estimation (ARE) shows that the ancestral range of *Coptis* and *Xanthorhiza* is unresolved but likely involved eastern North America, western North America and Japan. The most recent common ancestor of *Coptis* was likely distributed in western North America, southern East Asia and Japan. Within *Coptis*, two vicariance events and two dispersal events were inferred at the species level.

The estimated age for the split of these two genera highly coincides with the mid-Miocene Climatic Optimum (MMCO), which is one of Earth's most recent prolonged warming events, recorded in both the deep ocean and mid-to high-latitude continents. During this period, exchange of temperate plants between East Asia and North America could occur via the Bering land bridge. The uplift is a key factor in creating an increasingly drier climate in the North American interior around that time.

In *Coptis*, two vicariance episodes, involving Japan and western North America-southern East Asian and western North America and southern East Asian, took place at ca. 9.55 Ma and 7.78 Ma, respectively. Two dispersal events happened from mainland Asia to Japan at ca. 4.85 Ma

and from Japan to Taiwan at ca. 1.34 Ma, respectively. This study shed light on the past floristic exchanges between East Asia and North America, as well as within East Asia.