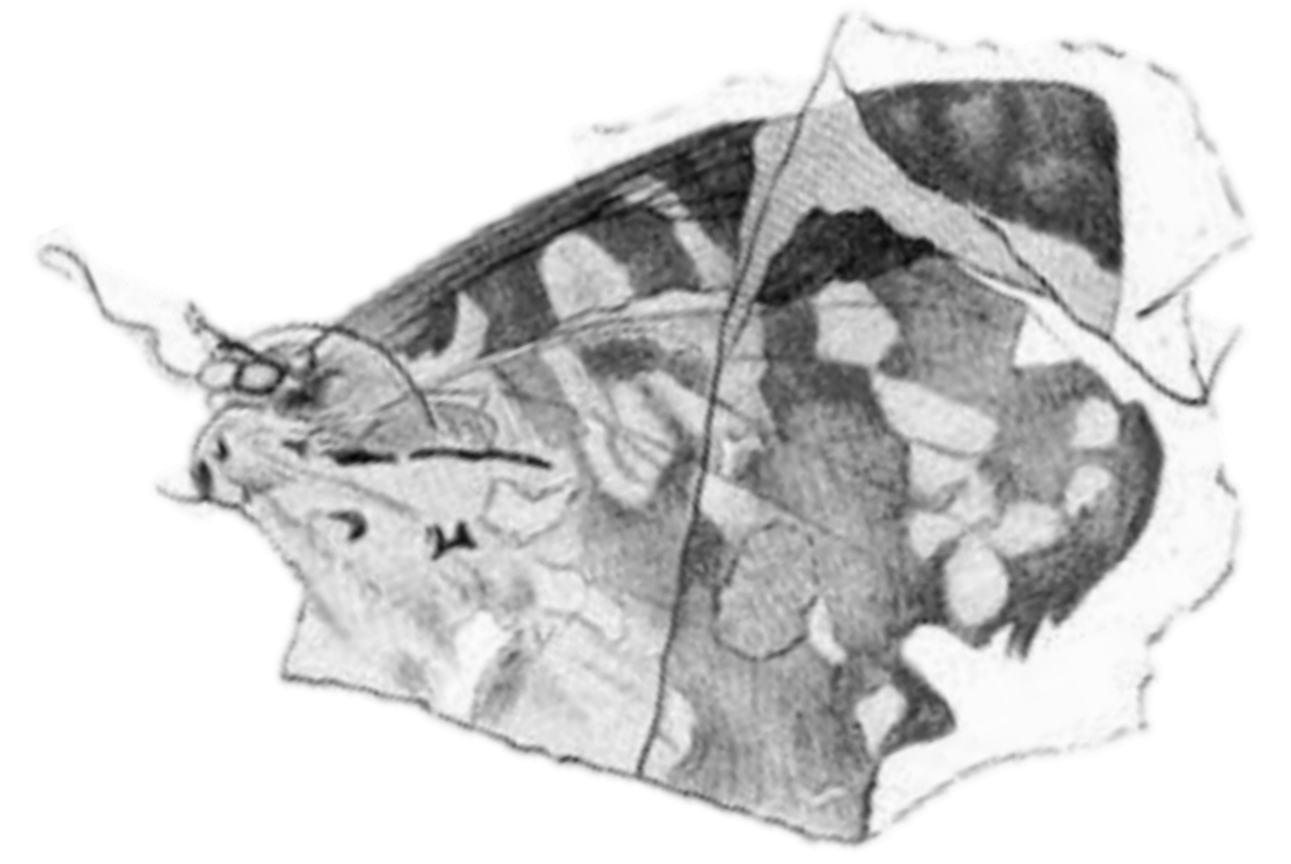


# FOSSILS ILLUMINATE THE AGE AND HISTORICAL BIOGEOGRAPHY OF PARNASSIINAE



*Doritites bosniackii*



*Thaites ruminiana*

NOÉMIE HÉVIN AND FABIEN CONDAMINE

The origin of Parnassiinae has been previously estimated *ca.* 38 Mya in **Central Asia** (Condamine et al. 2018)

Reconstructing time-calibrated phylogenies, including both extant and fossil taxa as lineages (**total-evidence dating**) under fossilized birth-death process, can provide new information on the age and historical biogeography inferred.

Dated to the late Oligocene (*Thaites ruminiana*) and late Miocene (*Doritites bosniackii*) in the **western Palearctic**, the two fossil taxa belonging to the Parnassiinae challenge the Central Asian origin.

## What impact does the inclusion of fossils have on what we know about the origin of the Parnassiinae?

### DATED PHYLOGENY MrBayes

#### Fossil placement tests

- Phylogeny vs. Dated phylogeny
- Changes in outgroups
- Number of morphological characters

4 mitochondrial and 1 nuclear genes  
180 morphological characters

#### Partition tests

From 1 partition to 9 partitions  
(one by codon position)

#### Clock model tests

Combinations of strict, autocorrelated and uncorrelated clocks

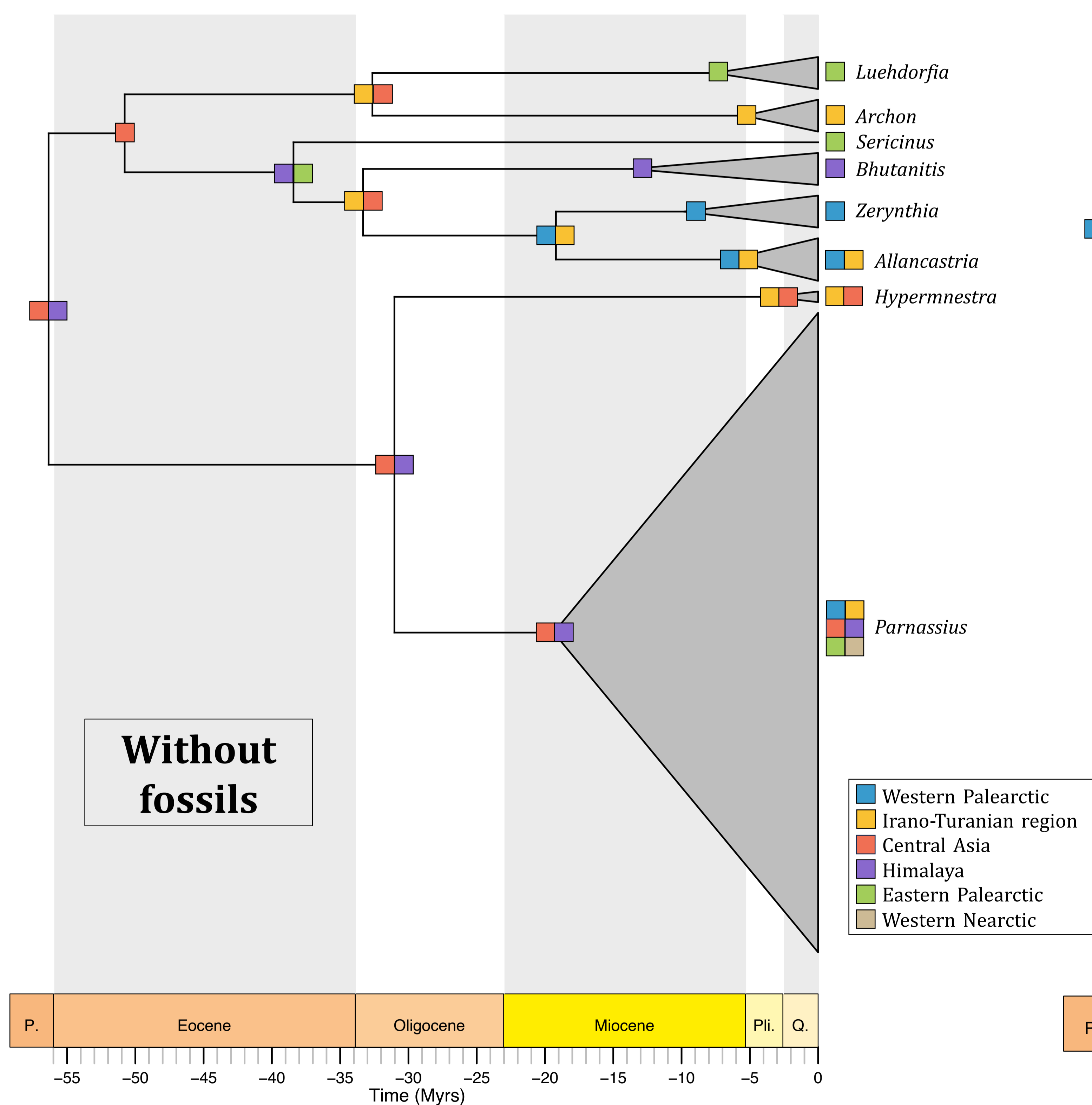
*Doritites bosniackii* sister to genus *Archon* (PP=0.99)

*Thaites ruminiana* sister to tribe Parnassiini (PP=0.58)

Best model using 3 uncorrelated clocks  
(mitochondrial, nuclear, morphology).

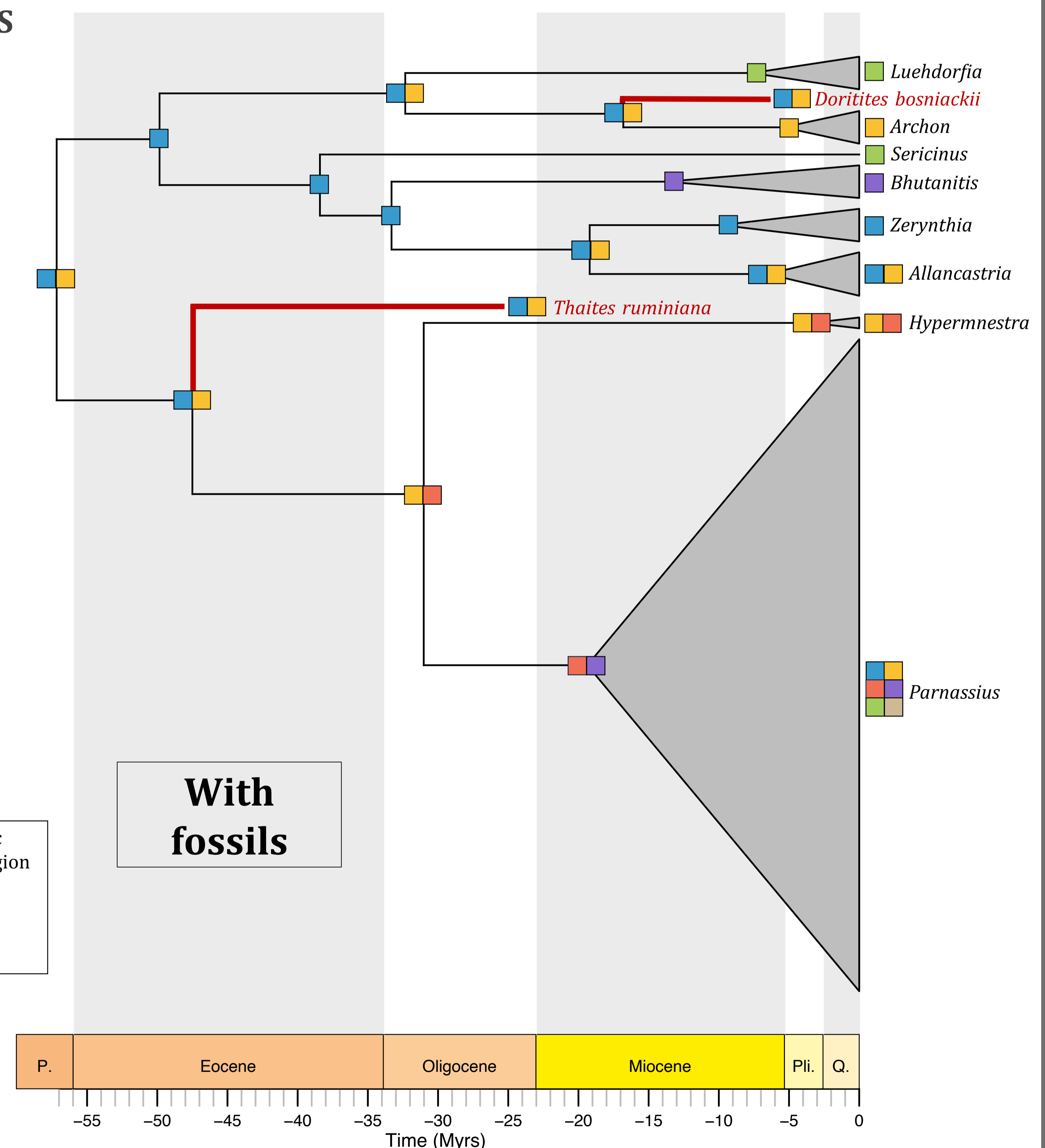
Older age than previously inferred with an origin recovered *ca.* 57 Mya

### HISTORICAL BIOGEOGRAPHY BioGeoBEARS



Origin in Central Asia and Himalaya, followed by colonization of western Palearctic and Irano-Turanian region

Origin of *Parnassius* coincides with the intensification of the Himalaya and Tibetan Plateau orogeny (early Miocene)



Origin in western Palearctic and Irano-Turanian region, followed by colonization of Central Asia and Himalaya

## Older origin of the Parnassiinae *ca.* 57 Mya in western Palearctic and Irano-Turanian region, instead of *ca.* 38 Mya in Central Asia.