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Plasticity in Evolution: How Phenotypic Plasticity Shapes the Phylogenetic Reconstruction of the Hominin Lineage



Full text

Phenotypic Variation, Plasticity and Acquiring New Adaptations

Phenotypic traits with a strong **genetic** basis are preferred for inferring **phylogenetic** relationships, whereas variations that are significantly affected and molded by the **environment** (i.e. plasticity) will be useful for inferring **behaviour**.

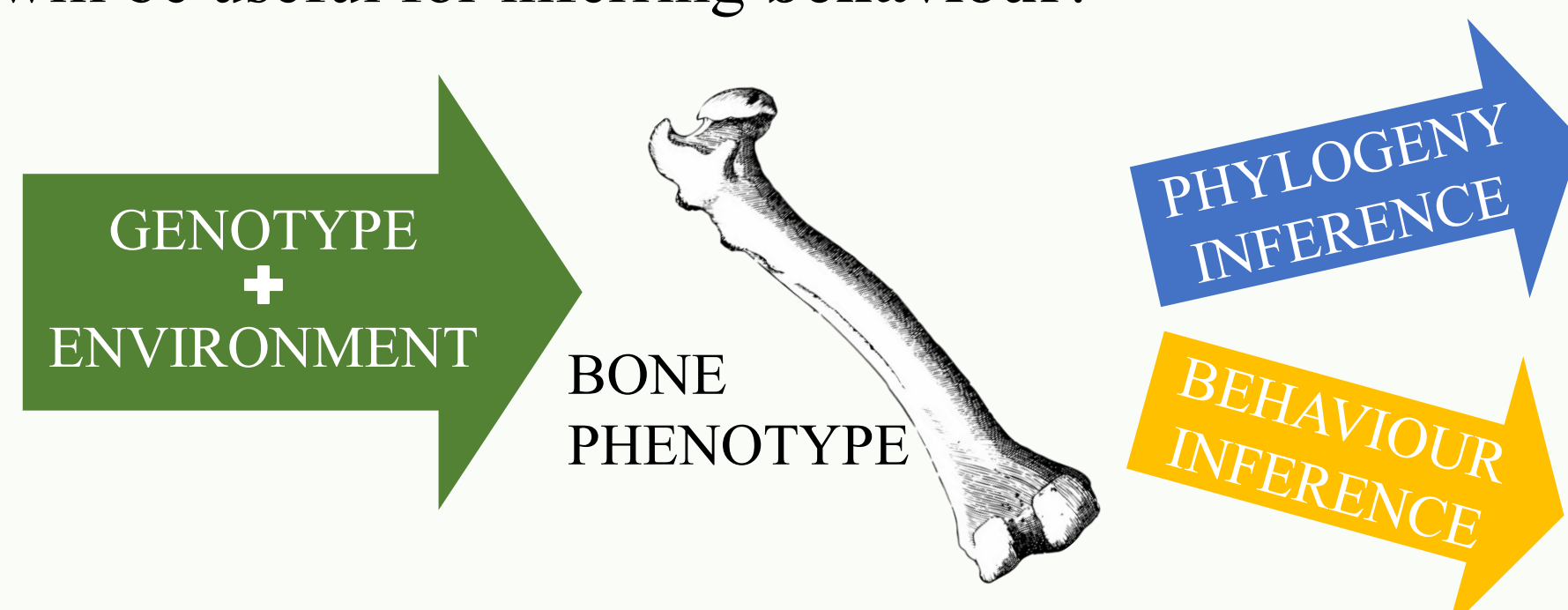


Figure 1. Phenotypic components and its inferences

Plasticity enables organisms to adapt their biological structures on timescales that are too quick for **genetic change** but too long for effective **homeostatic** balance.

Ecological cycle duration		Adaptation	
Years		Mode	Process
0.00000001	seconds	Physiologic	Homeostasis & Allostasis
0.0001	hours		
0.001	days		
0.1	months	Developmental Intergenerational	Plasticity Inertia
1	years		
10	decades		
100	centuries	Genetic	Natural selection
1000	millenia		
1000000	millions		

Figure 2. Timescales of human adaptability [Kuzawa and Bragg, 2012].

Reconstructing the Hominin Phylogeny

- Unclear correlation between morphometrics and phylogeny: the “**homoiology hypothesis**”. Regions of the skull subject to masticatory strain are more variable.
- Fossils as a tool of dating trees.

Table 1. Hominins displaying different cranial morphologies.

<i>Paranthropus aethiopicus</i>	<i>Paranthropus boisei</i>	<i>Paranthropus robustus</i>	<i>Homo habilis</i>	<i>Homo rudolfensis</i>
KNM WT-17.000	OH 5	SK 48	OH 4	KNM ER-1470
2.5-2.3 MYA	2.3-1.4 MYA	2-1.5 MYA	2.4-1.4 MYA	2.4-1.6 MYA
Ethiopia	Tanzania	South Africa	Tanzania	Kenya

Determine to what extent is **cranial** and **dental** morphology reliable for inferring the phylogeny from the Plio-Pleistocene hominins

Materials and Methods

1.

Craniodental matrix compilation

Dembo et al. 2015

Dembo et al. 2016

Wood, 2020

391 characters	
243 cranial	148 dental
22 hominin	
22 hominin	
2 outgroup	

List of **species and specimens**, associated with a geological **date**

List of **craniodental characters, definitions** and character states

2.

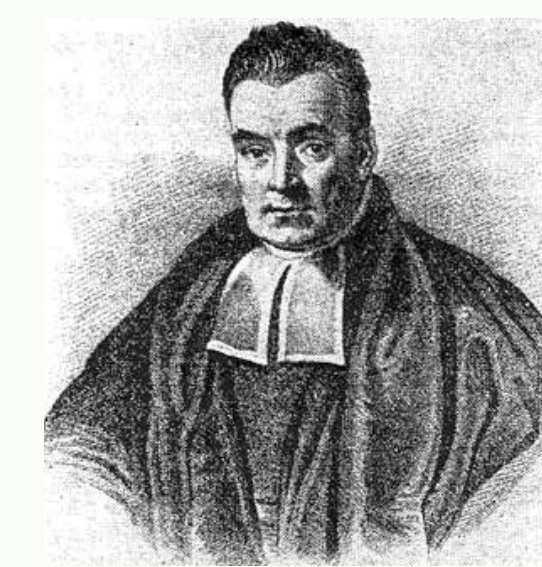
Unpolarizing characters

Absent (0)
Small (1)
Intermediate (2)
Medium (3)
Large (4)

Python 3.11

3.

Phylogenetic reconstruction



Tip-dating fossils

MrBayes 3.2.7a

4.

Tree editing



FigTree v1.4.4

Results

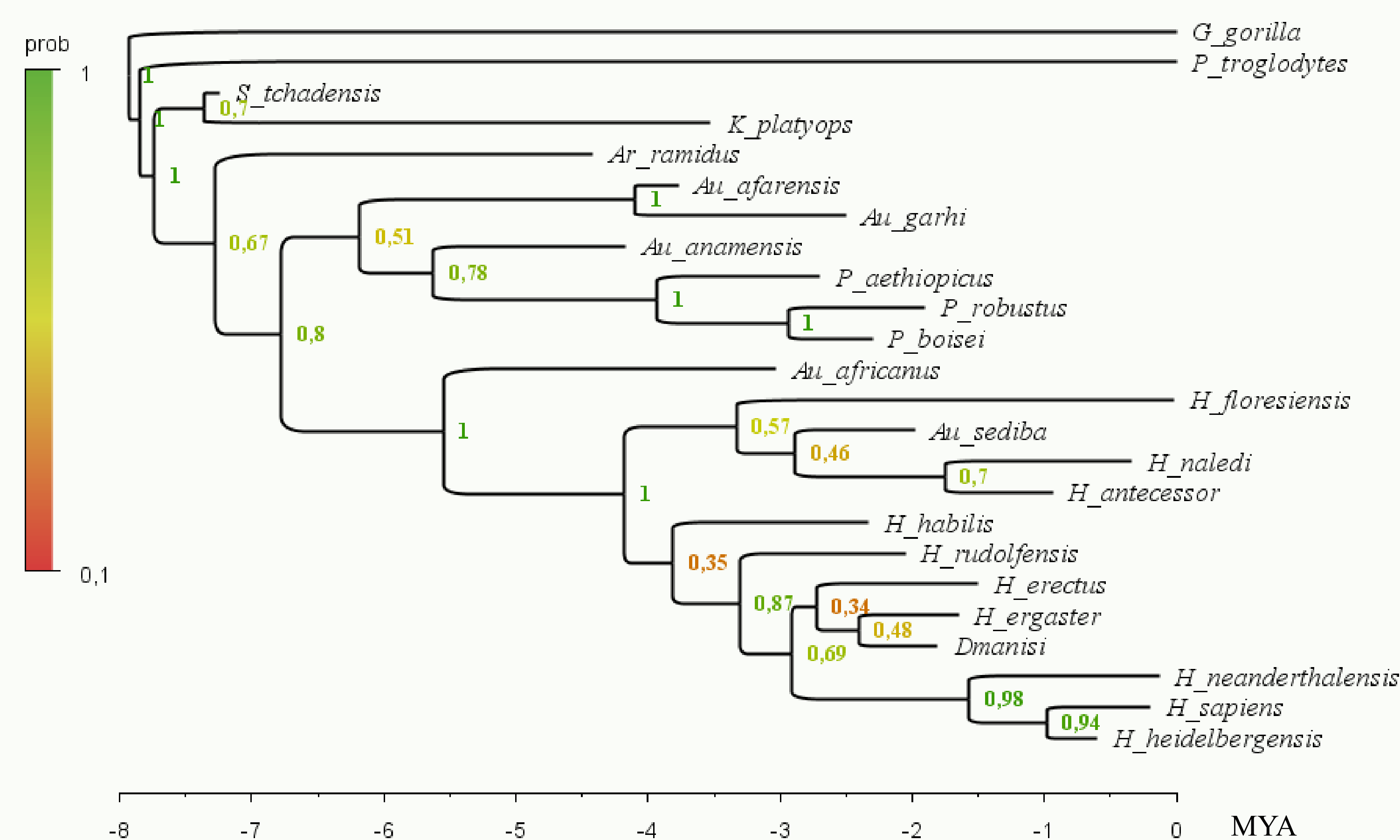


Figure 3. Phylogenetic reconstruction based on **cranial** characters

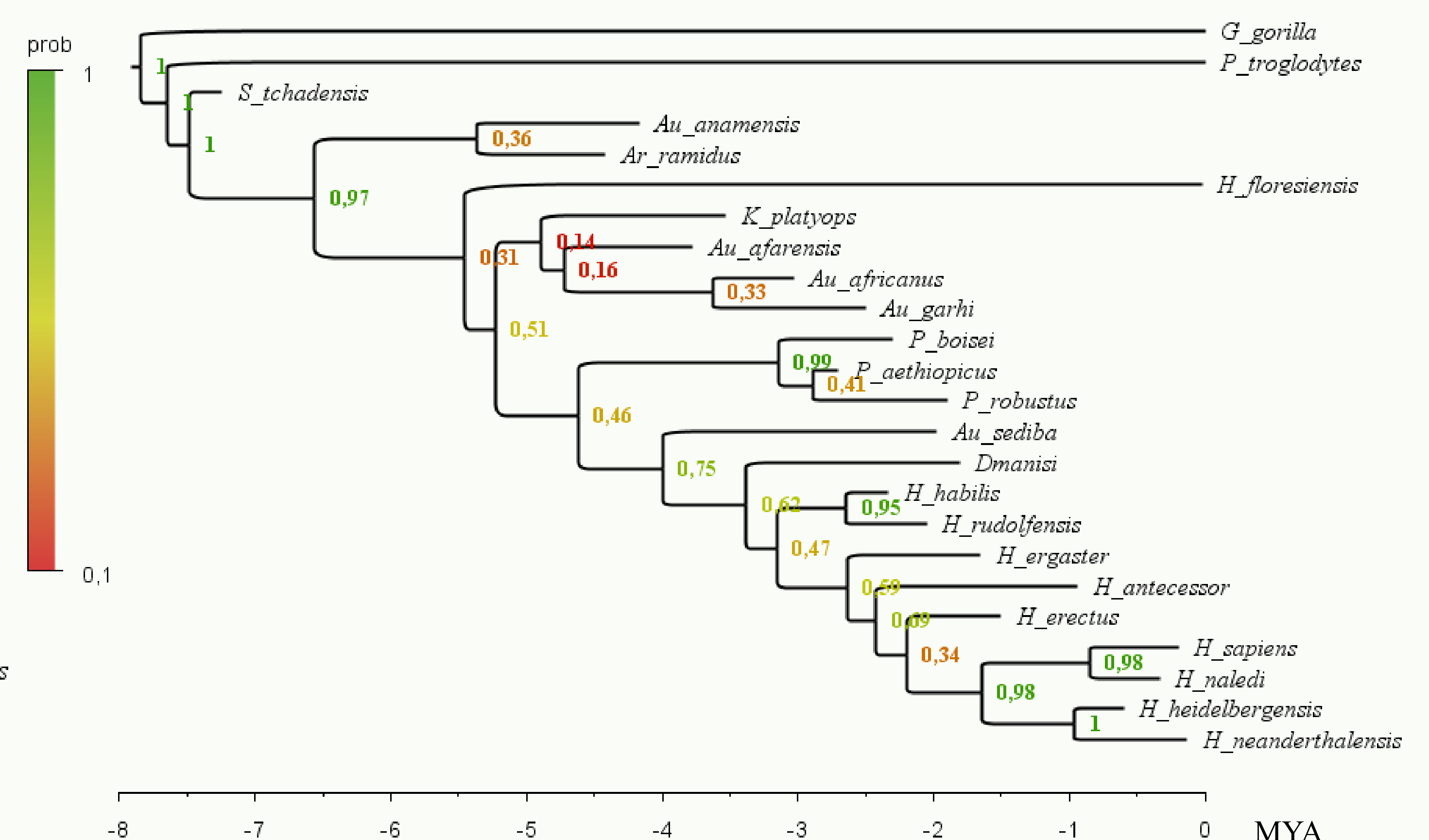


Figure 4. Phylogenetic reconstruction based on **dental** characters

Conclusions

I. **New habitats** and environments promote the acquisition of new behaviours, and therefore **new adaptations** may be enhanced as a result of phenotypic plasticity.

II. Inevitably, phylogenetic reconstructions are being **shaped by phenotypic plasticity**.

III. **Cranial** characters conserve a stronger phylogenetic signal, while **dental** morphology is not reliable for inferring the phylogeny from the Plio-Pleistocene hominins.

IV. Morphological characters are the most **accurate way of dating** and resolving the evolutionary relationships between fossil and contemporary taxa.

V. Extra caution when **selecting characters** for reconstructing any phylogeny from morphological data.

Relevant references

- Dembo, M., et al. (2015). Bayesian analysis of a morphological supermatrix sheds light on controversial fossil hominin relationships. *Proceedings of the Royal Society B: Biological Sciences*, 282(1812):20150943.
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- Kuzawa, C. and Bragg, J. (2012). Plasticity in human life history strategy. *Current Anthropology*, 53(S6):S369–S382.
- Wood, T. (2020). An expanded character set for evaluating the phylogenetic position of Homo floresiensis, page 312. *American Association of Physical Anthropologists*, Los Angeles, CA.