Supplementary Information for

Phylogenomic analysis of velvet worms (Onychophora) uncovers an evolutionary radiation in the Neotropics

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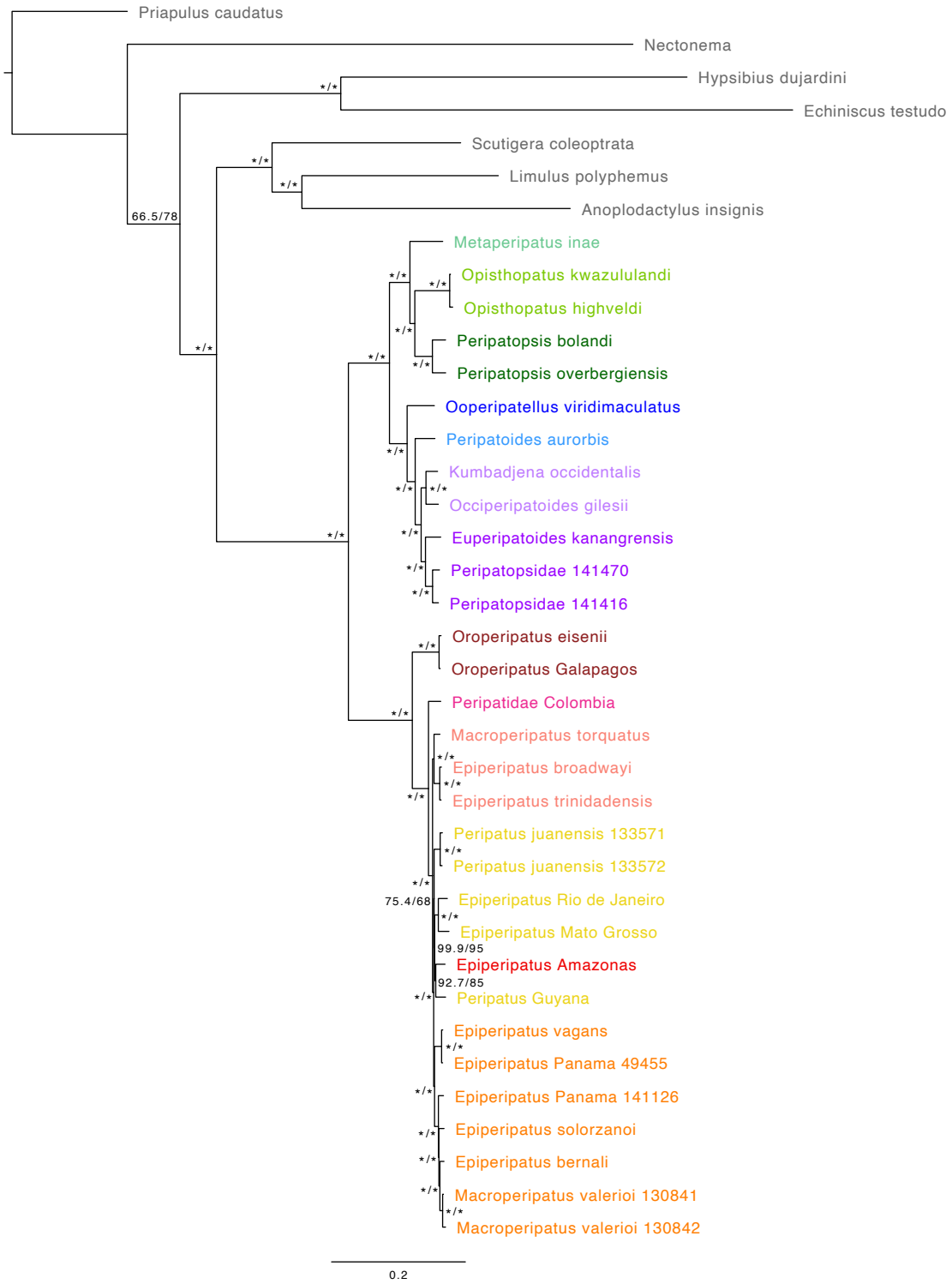

Figure S1. Phylogeny inferred from IQ-TREE analysis of M1. Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

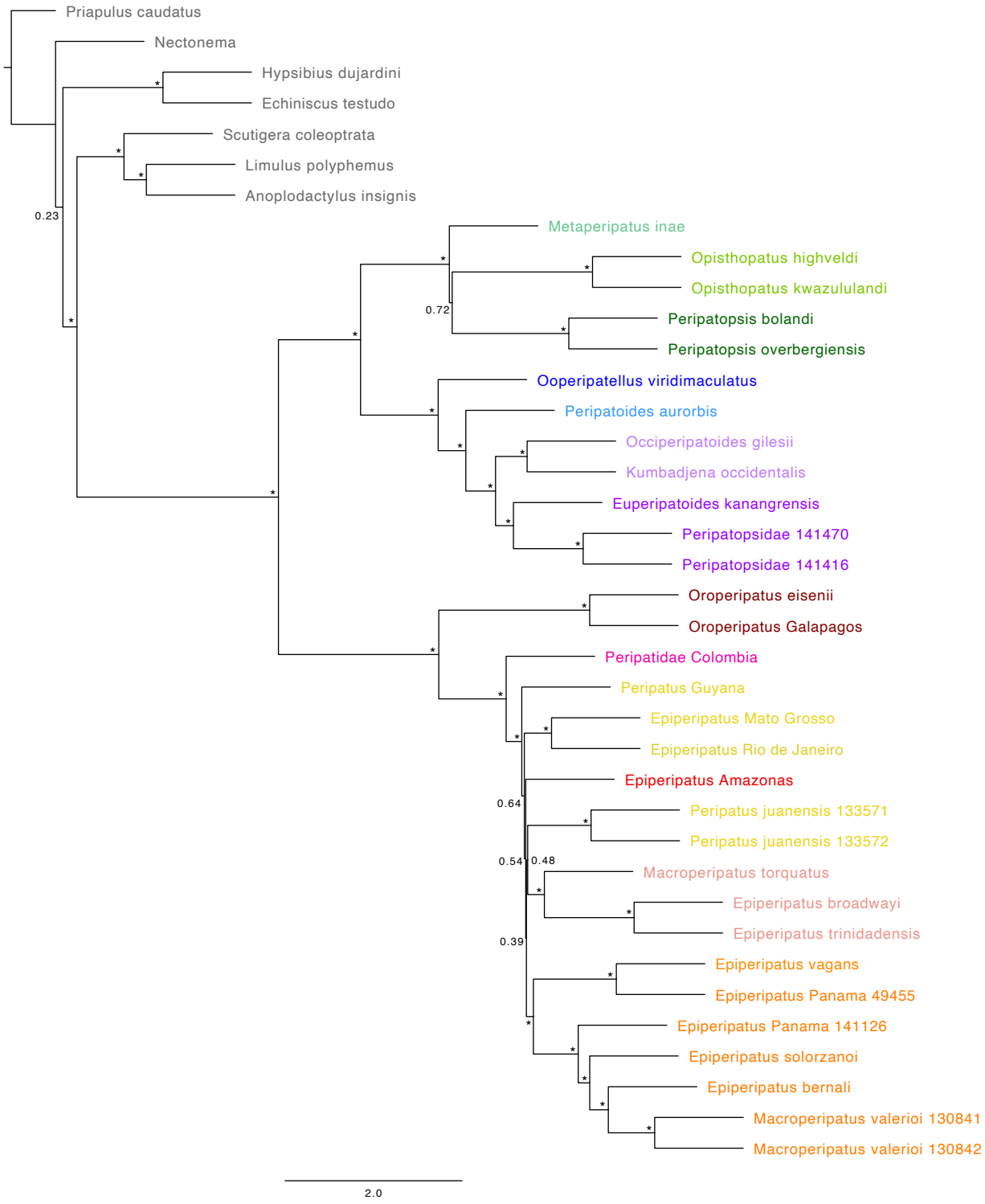

Figure S2. Phylogeny inferred from ASTRAL analysis of M1. Asterisks (*) mark nodes with full support; remaining nodes show local posterior probabilities.

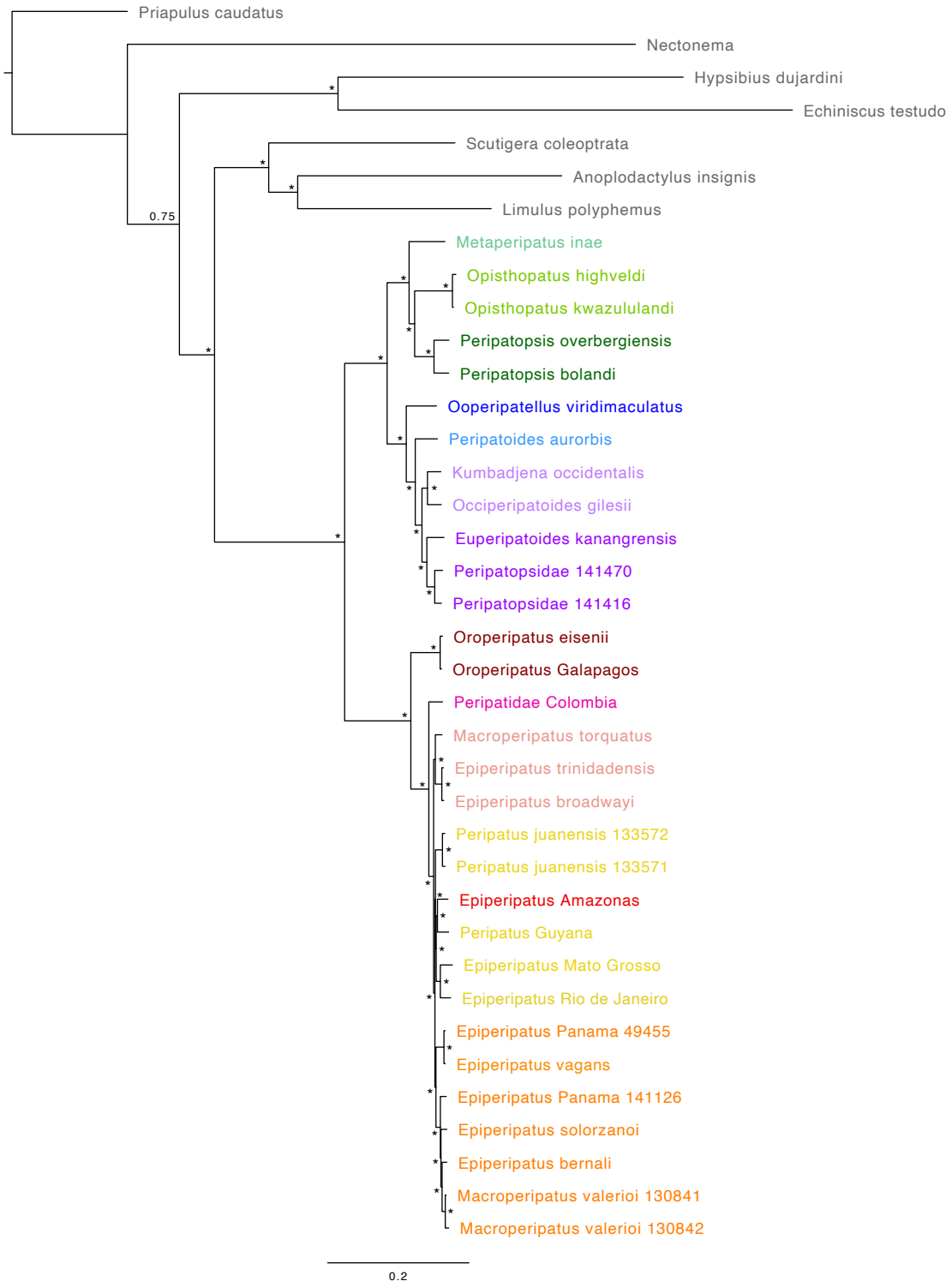

Figure S3. Phylogeny inferred from ExaBayes analysis of M1. Asterisks (*) mark nodes with full support; remaining nodes show the posterior probability.

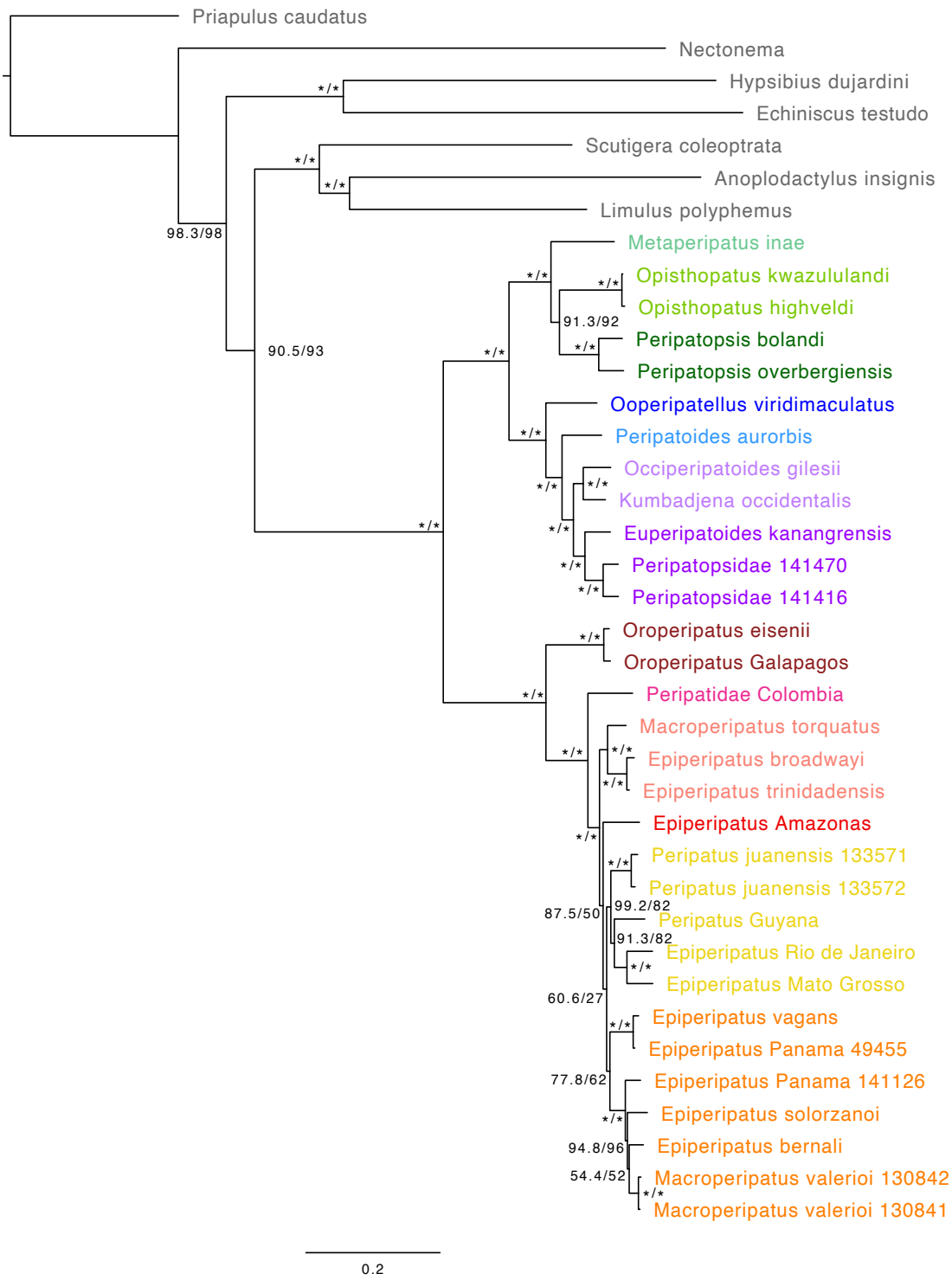

Figure S4. Phylogeny inferred from IQ-TREE analysis of M2. Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

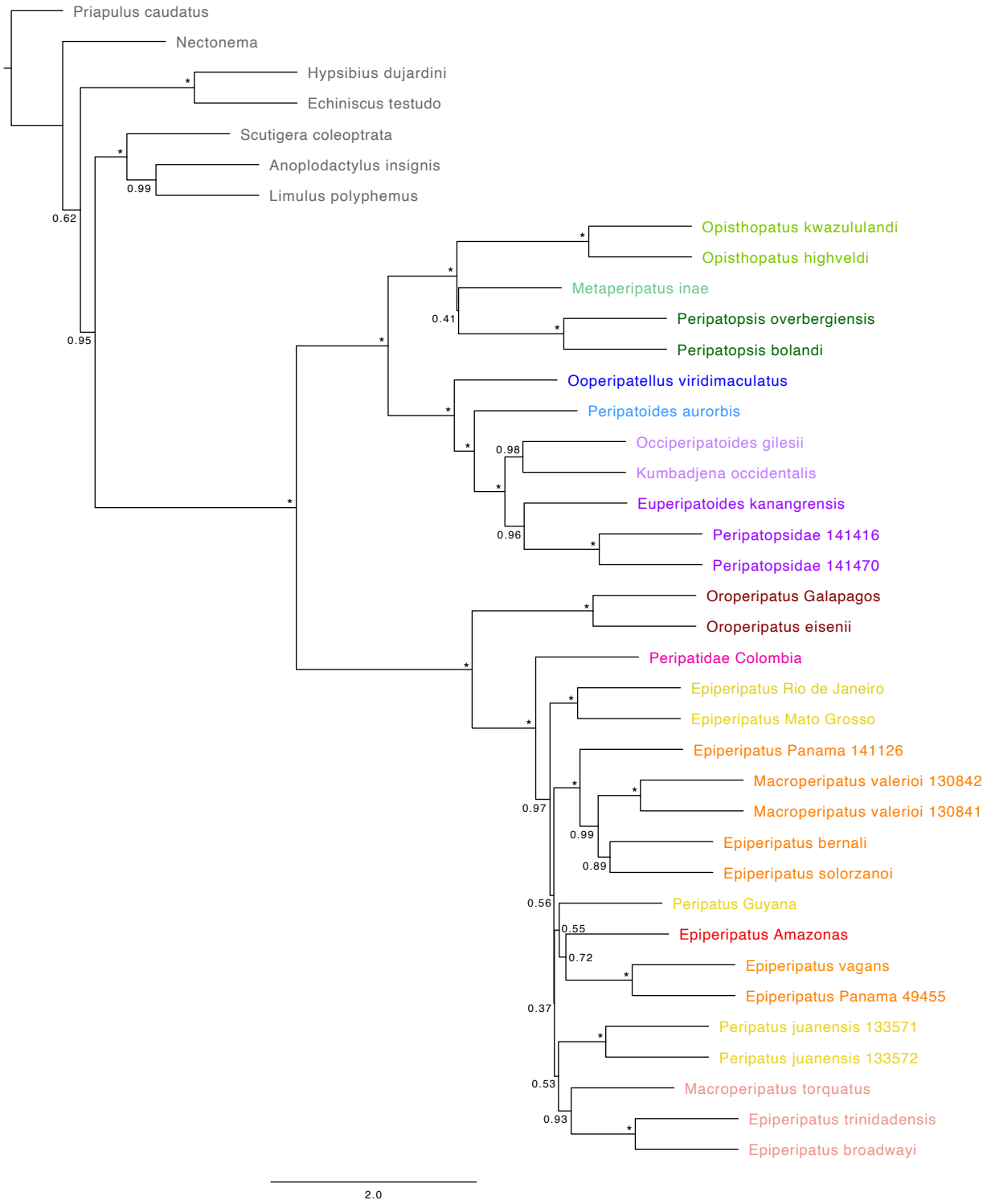

Figure S5. Phylogeny inferred from ASTRAL analysis of M2. Asterisks (*) mark nodes with full support; remaining nodes show local posterior probabilities.

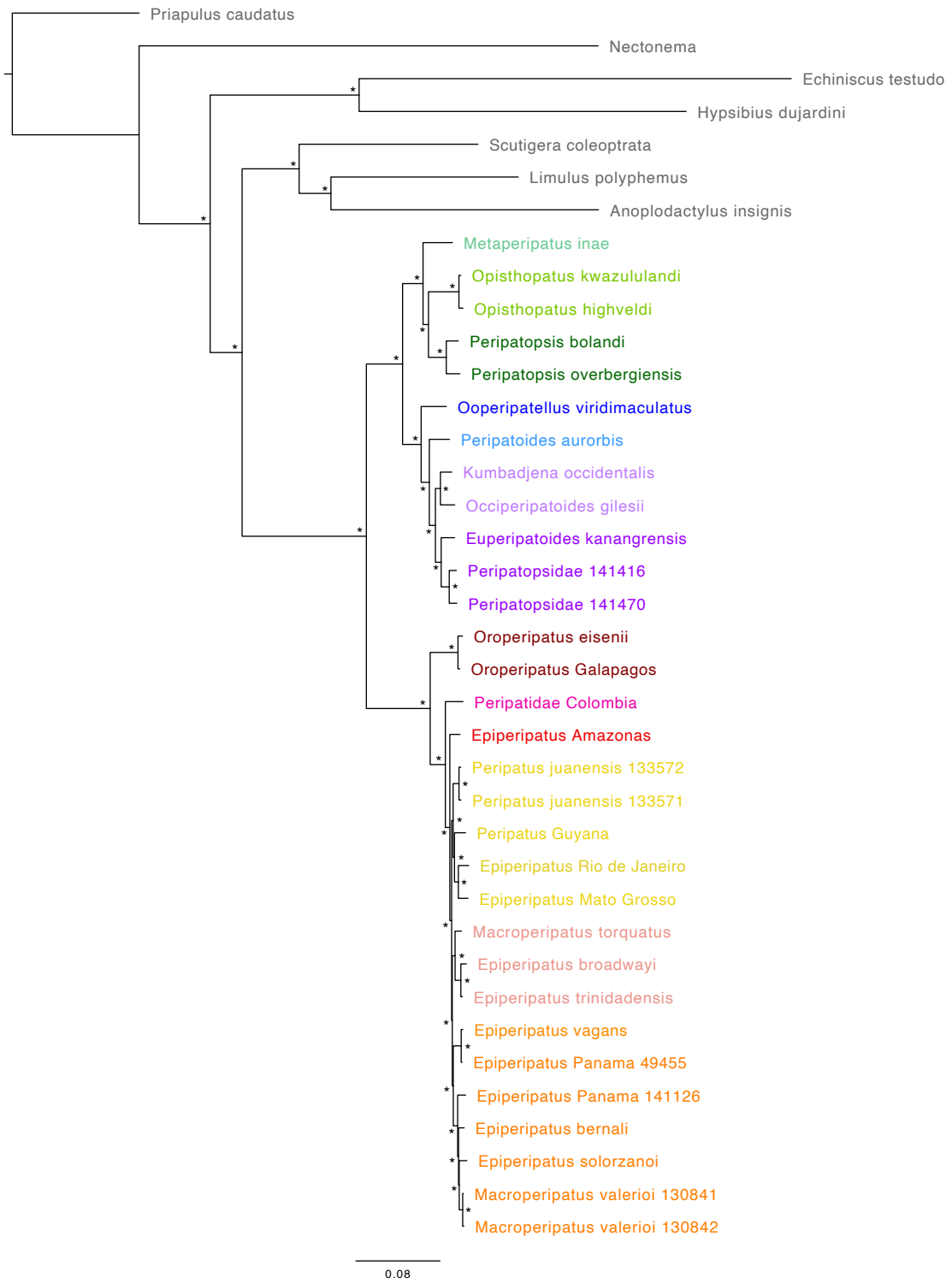

Figure S6. Phylogeny inferred from ExaBayes analysis of M2. Asterisks (*) mark nodes with full support.

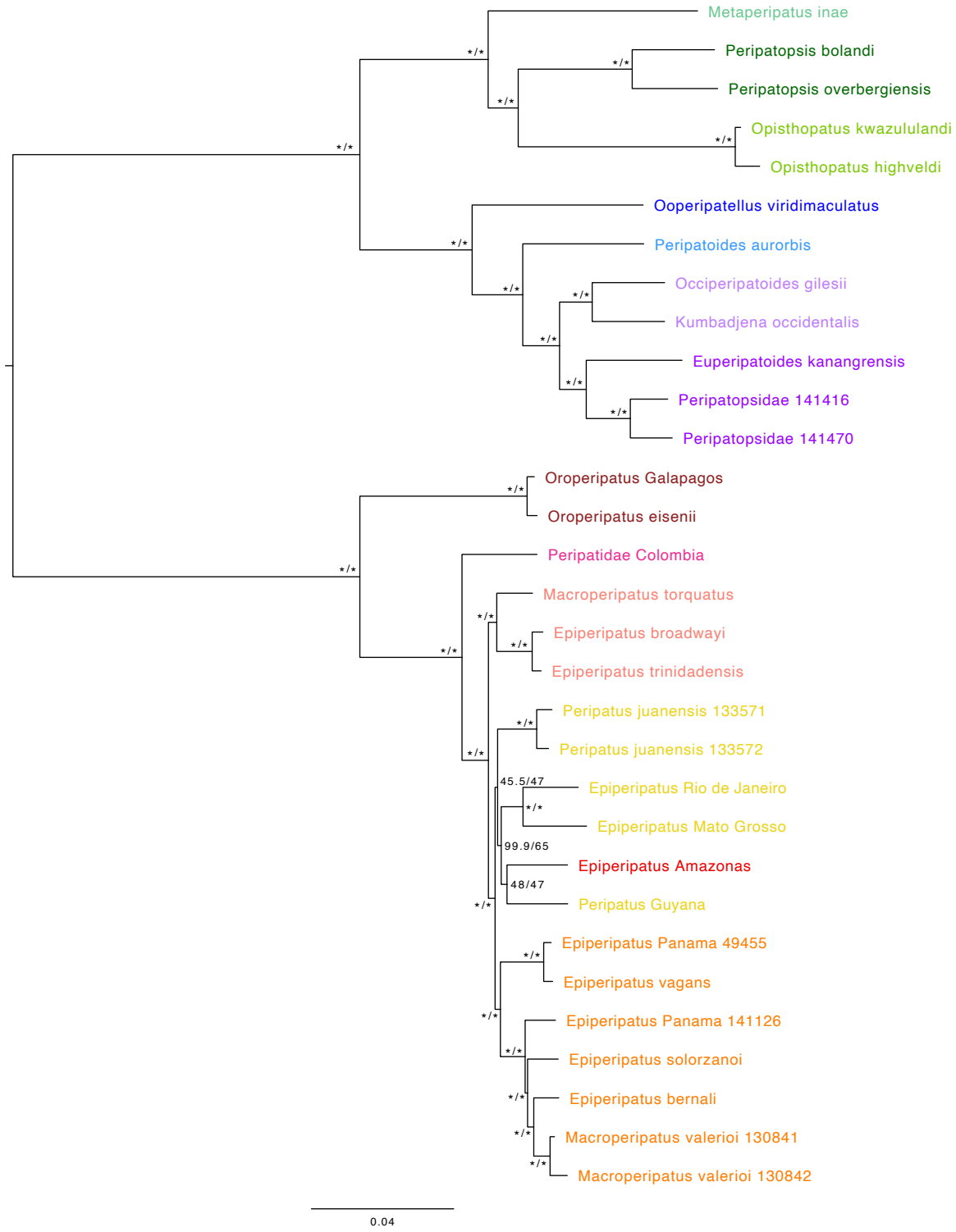

Figure S7. Phylogeny inferred from IQ-TREE analysis of M3. Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

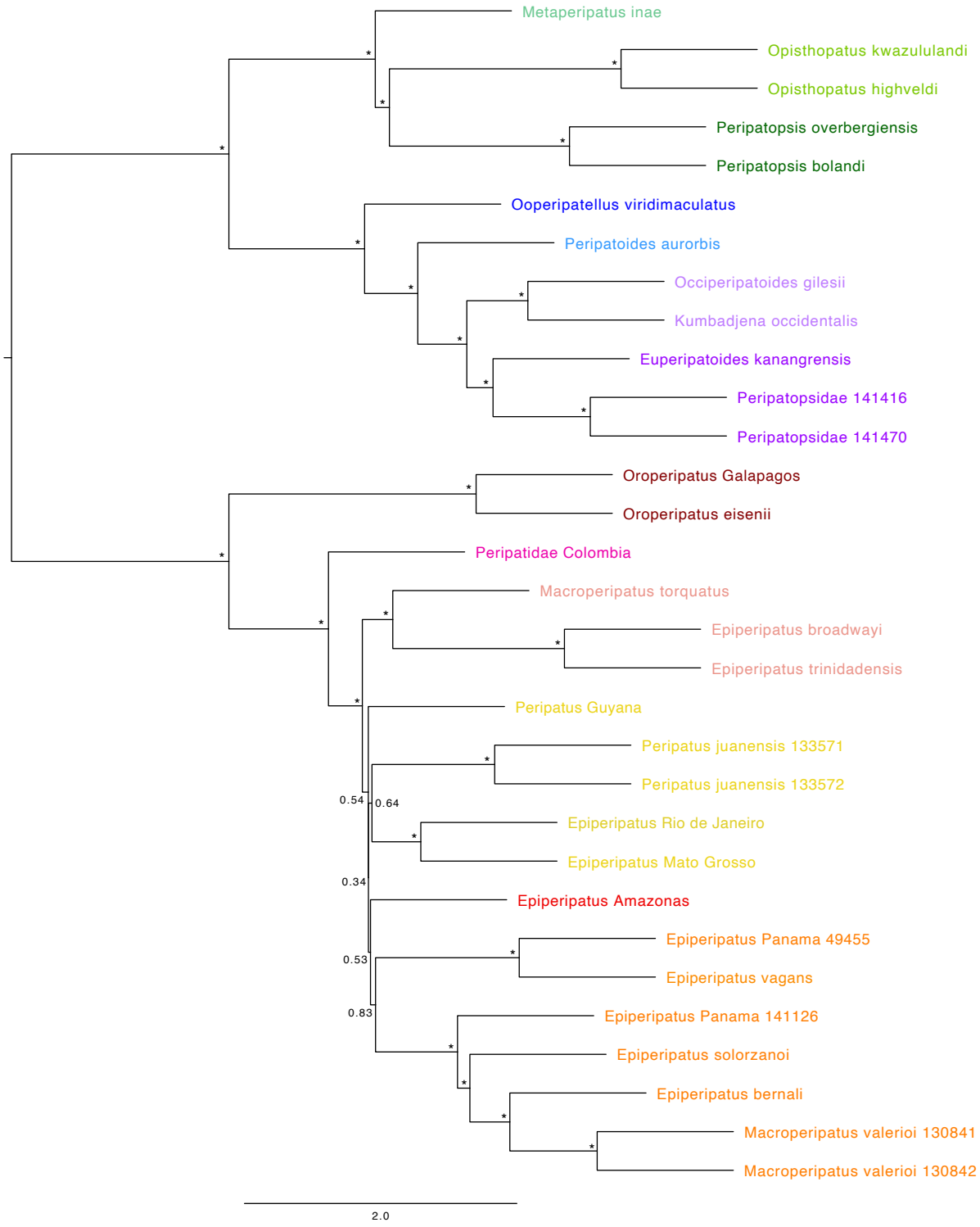

Figure S8. Phylogeny inferred from ASTRAL analysis of M3. Asterisks (*) mark nodes with full support; remaining nodes show local posterior probabilities.

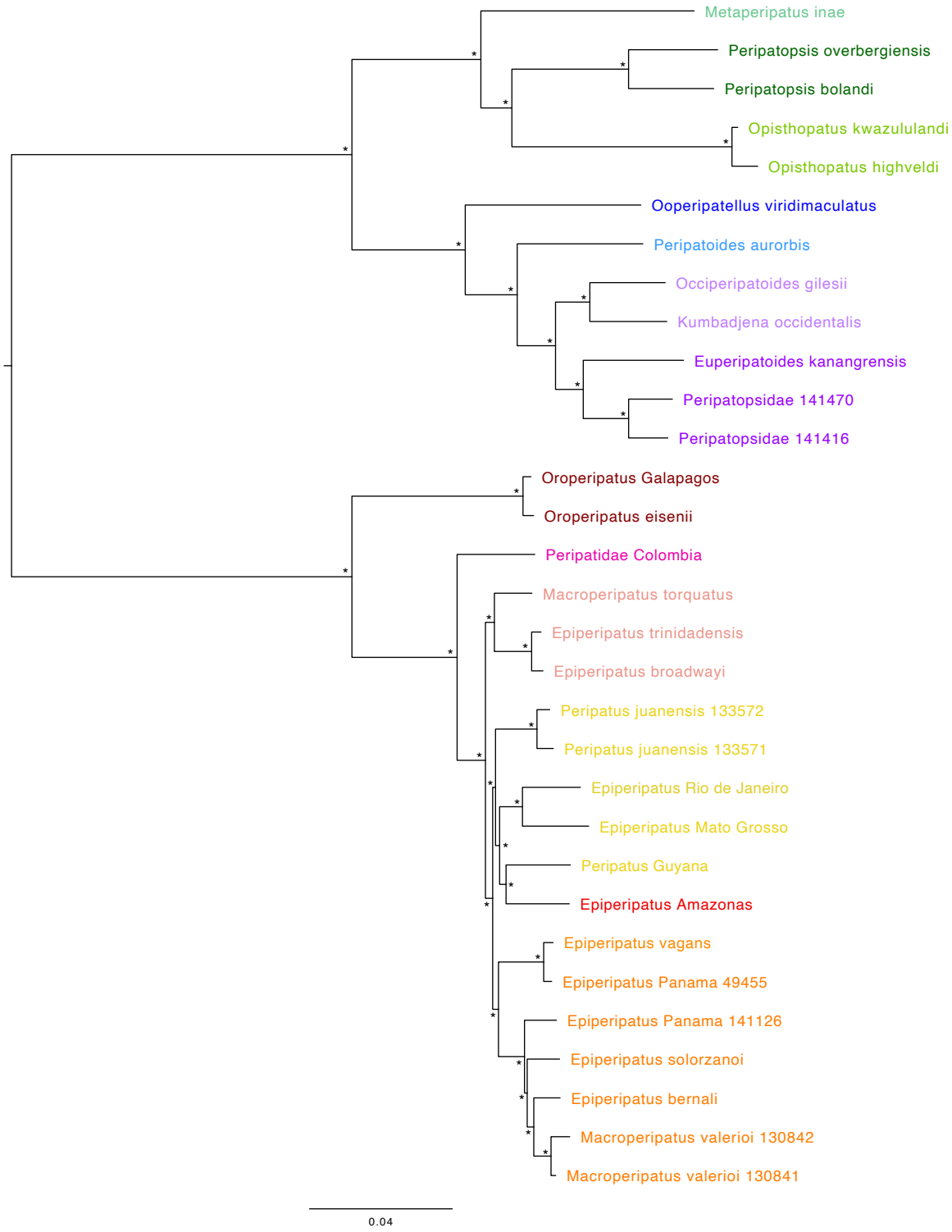

Figure S9. Phylogeny inferred from ExaBayes analysis of M3. Asterisks (*) mark nodes with full support.

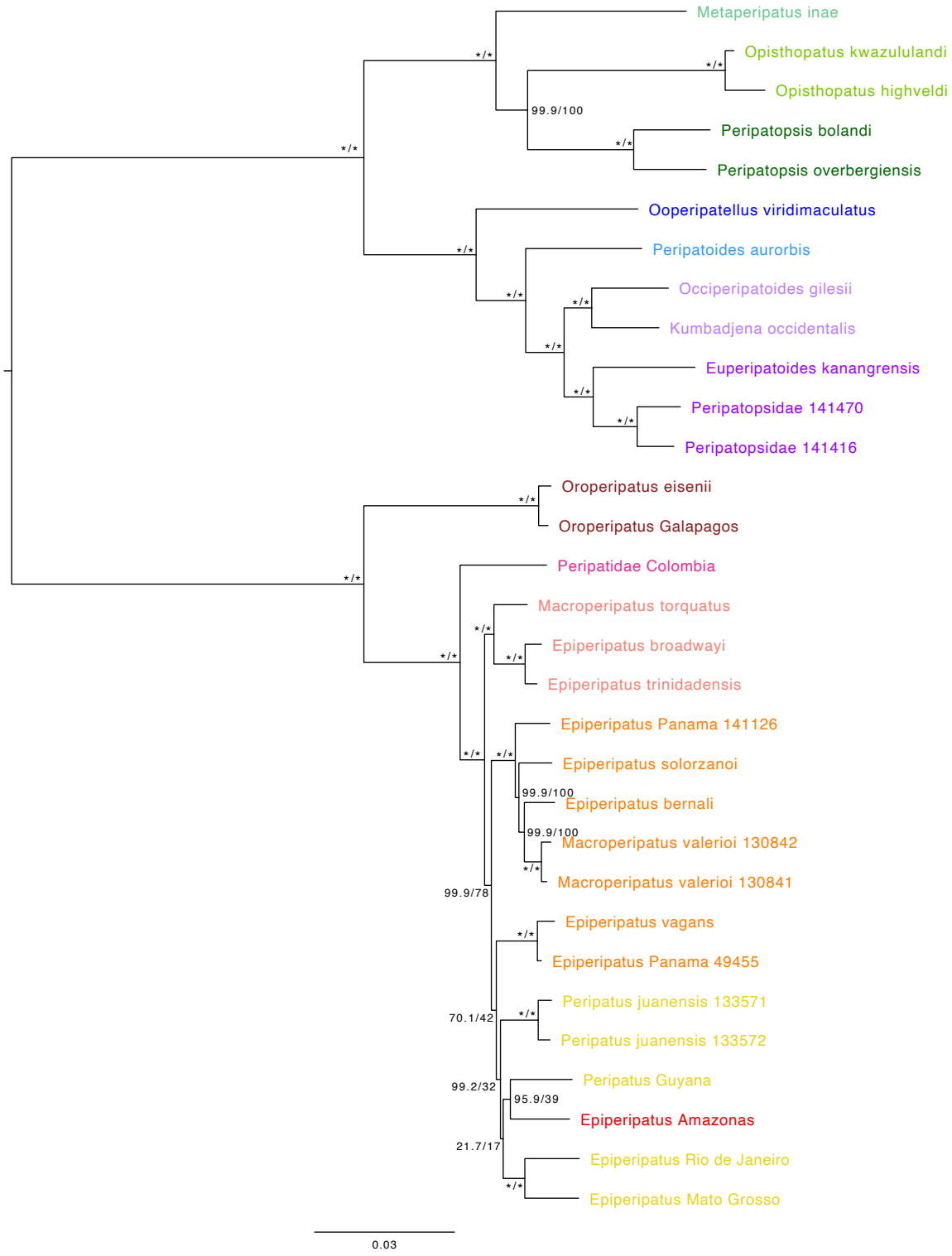

Figure S10. Phylogeny inferred from IQ-TREE analysis of M4. Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

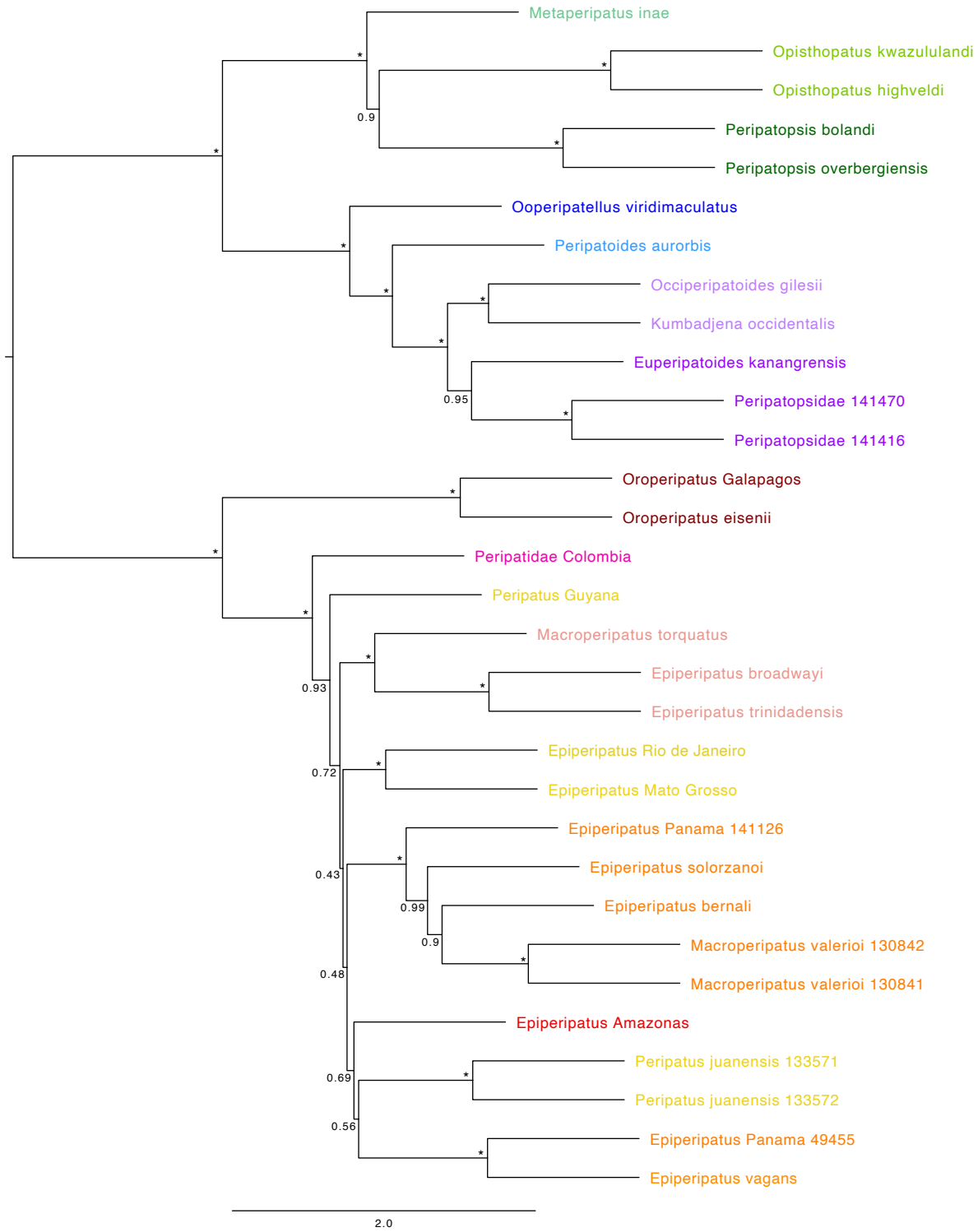

Figure S11. Phylogeny inferred from ASTRAL analysis of M4. Asterisks (*) mark nodes with full support; remaining nodes show local posterior probabilities.

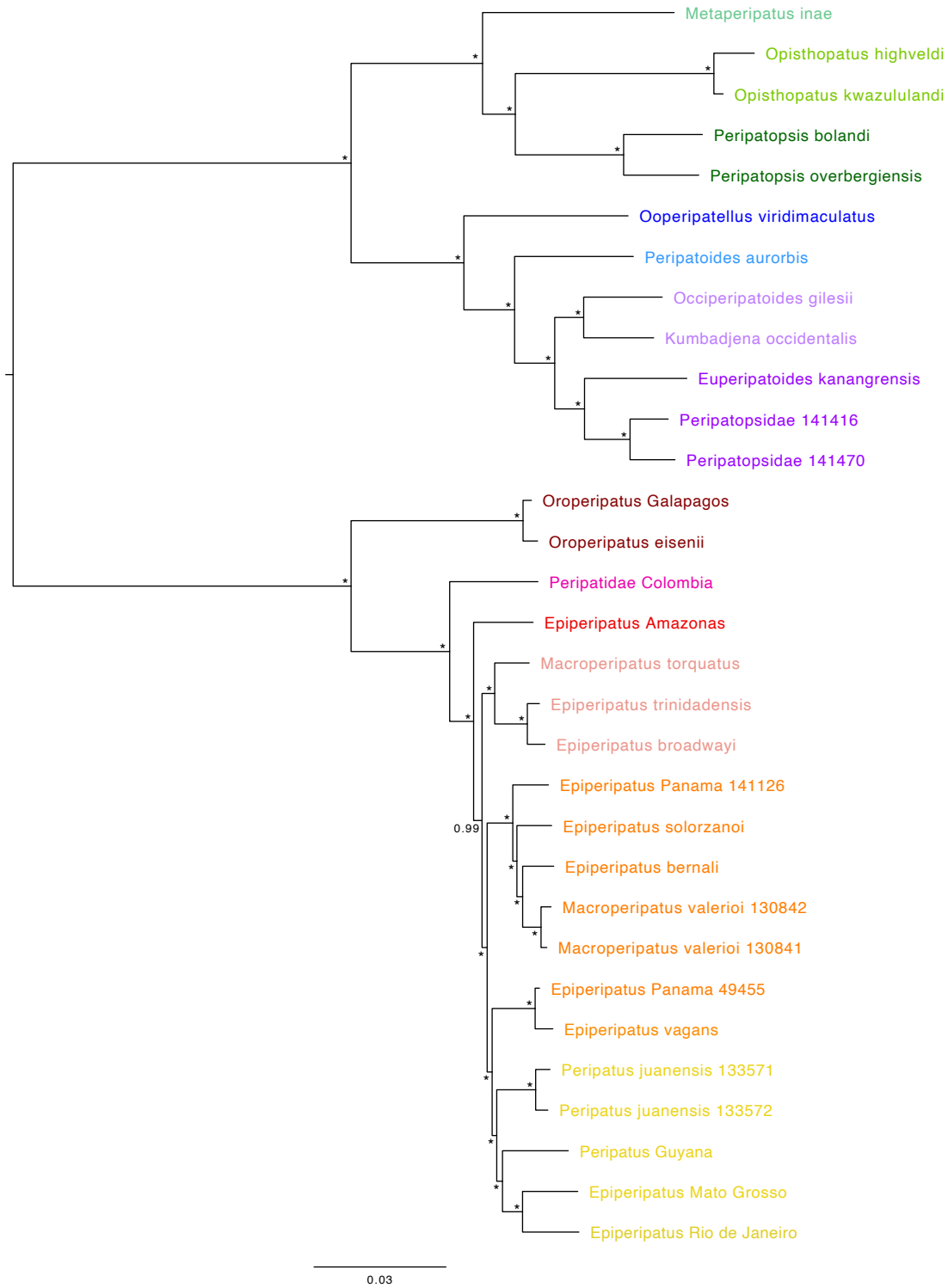

Figure S12. Phylogeny inferred from ExaBayes analysis of M4. Asterisks (*) mark nodes with full support; remaining nodes show the posterior probability.

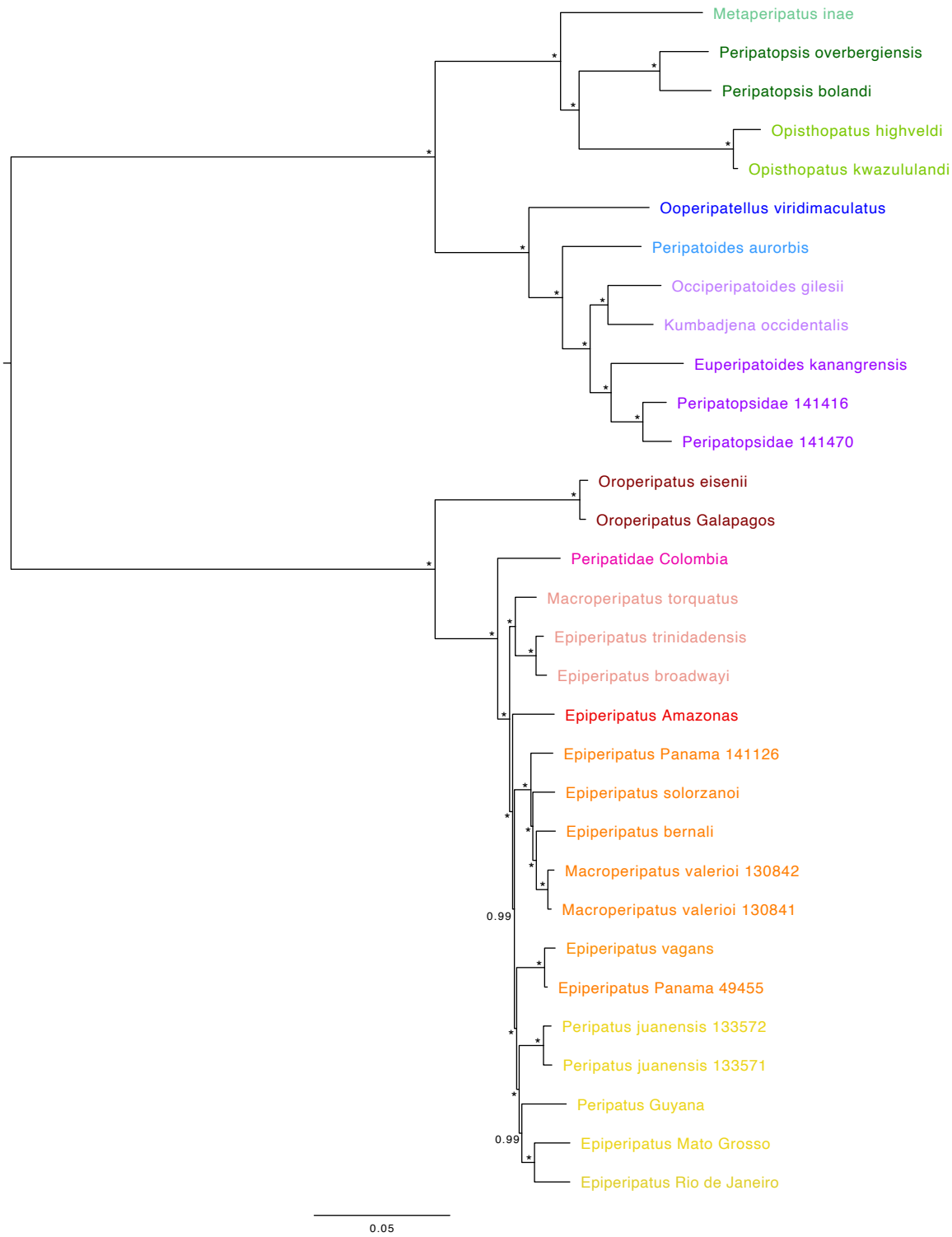

Figure S13. Phylogeny inferred from PhyloBayes analysis of M4. Asterisks (*) mark nodes with full support; remaining nodes show the posterior probability.

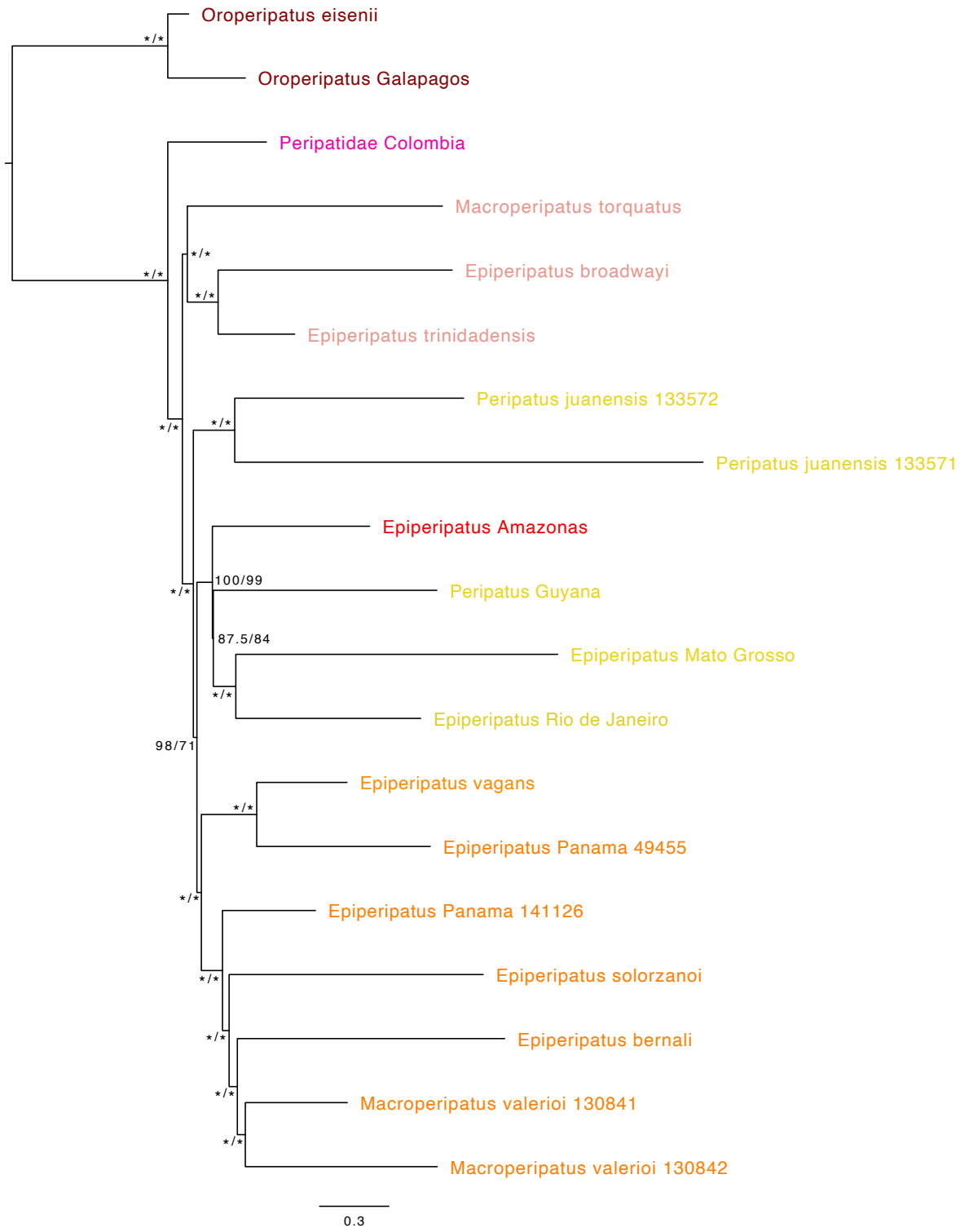

Figure S14. Phylogeny of Neopatida inferred from IQ-TREE analysis of M5. Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

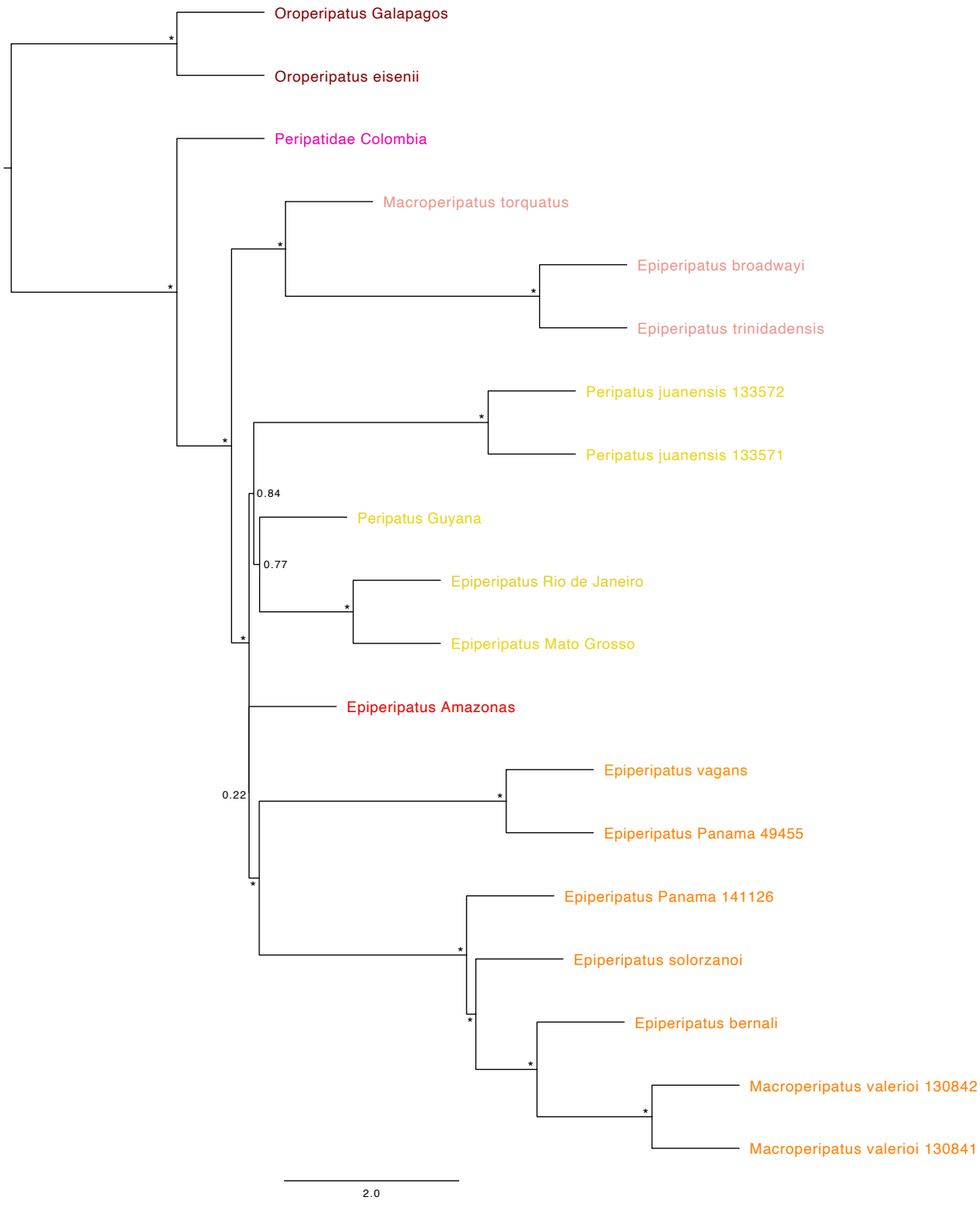

Figure S15. Phylogeny of Neopatida inferred from ASTRAL analysis of M5. Asterisks (*) mark nodes with full support; remaining nodes show local posterior probabilities.

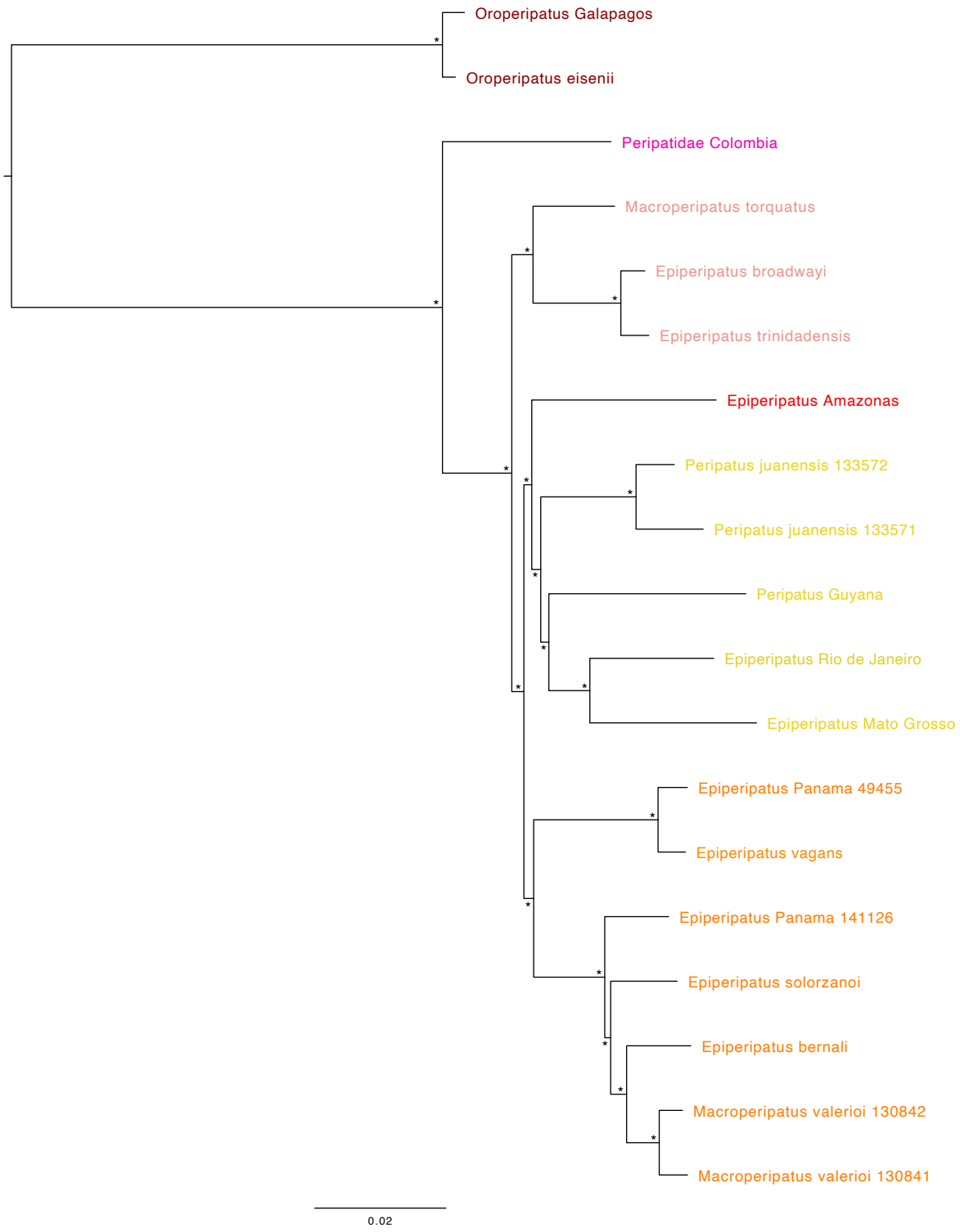

Figure S16. Phylogeny of Neopatida inferred from ExaBayes analysis of M5. Asterisks (*) mark nodes with full support.

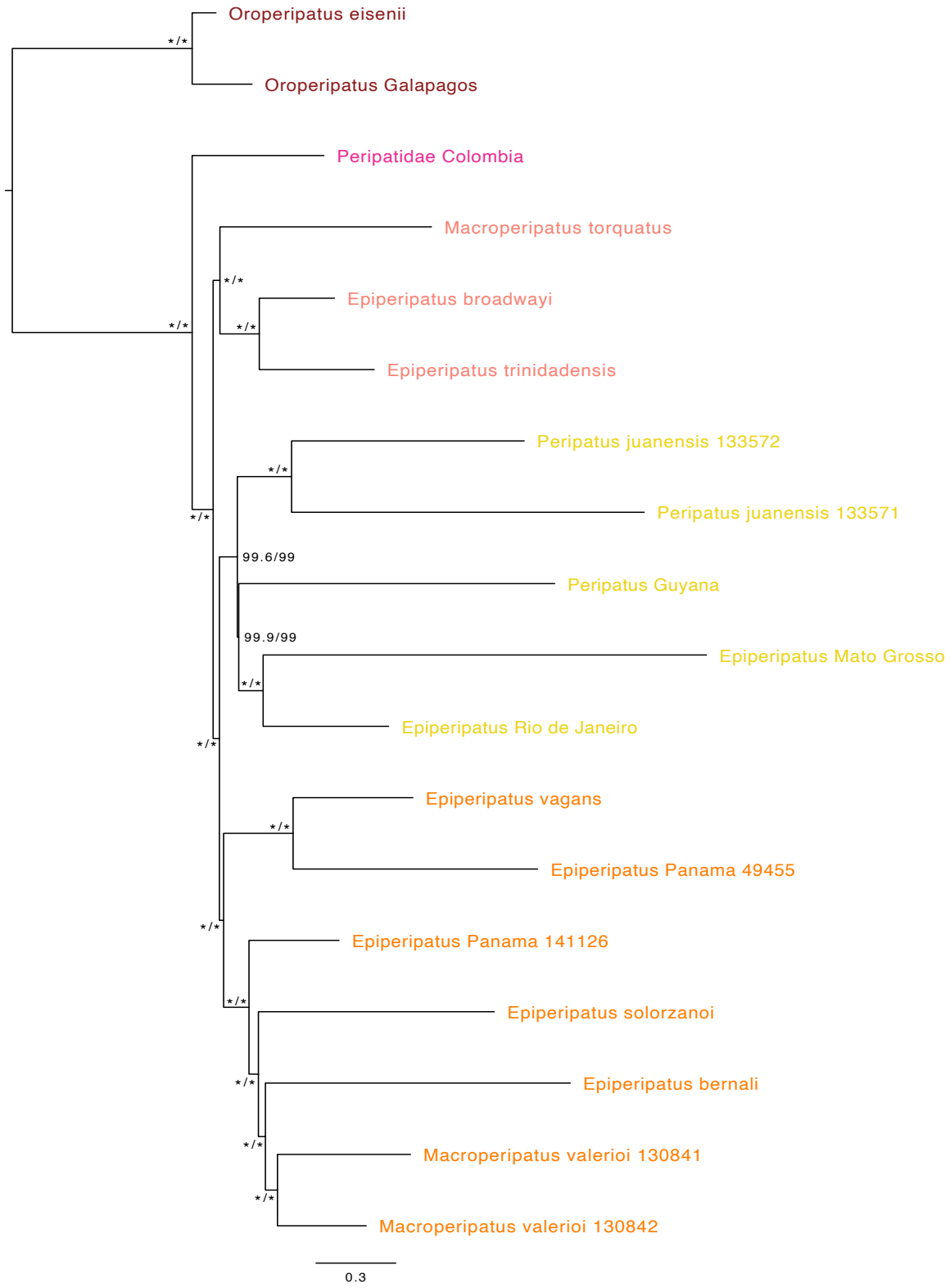

Figure S17. Phylogeny inferred from IQ-TREE analysis of M5, excluding *Epiperipatus* sp. Amazonas (MCZ-136557). Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

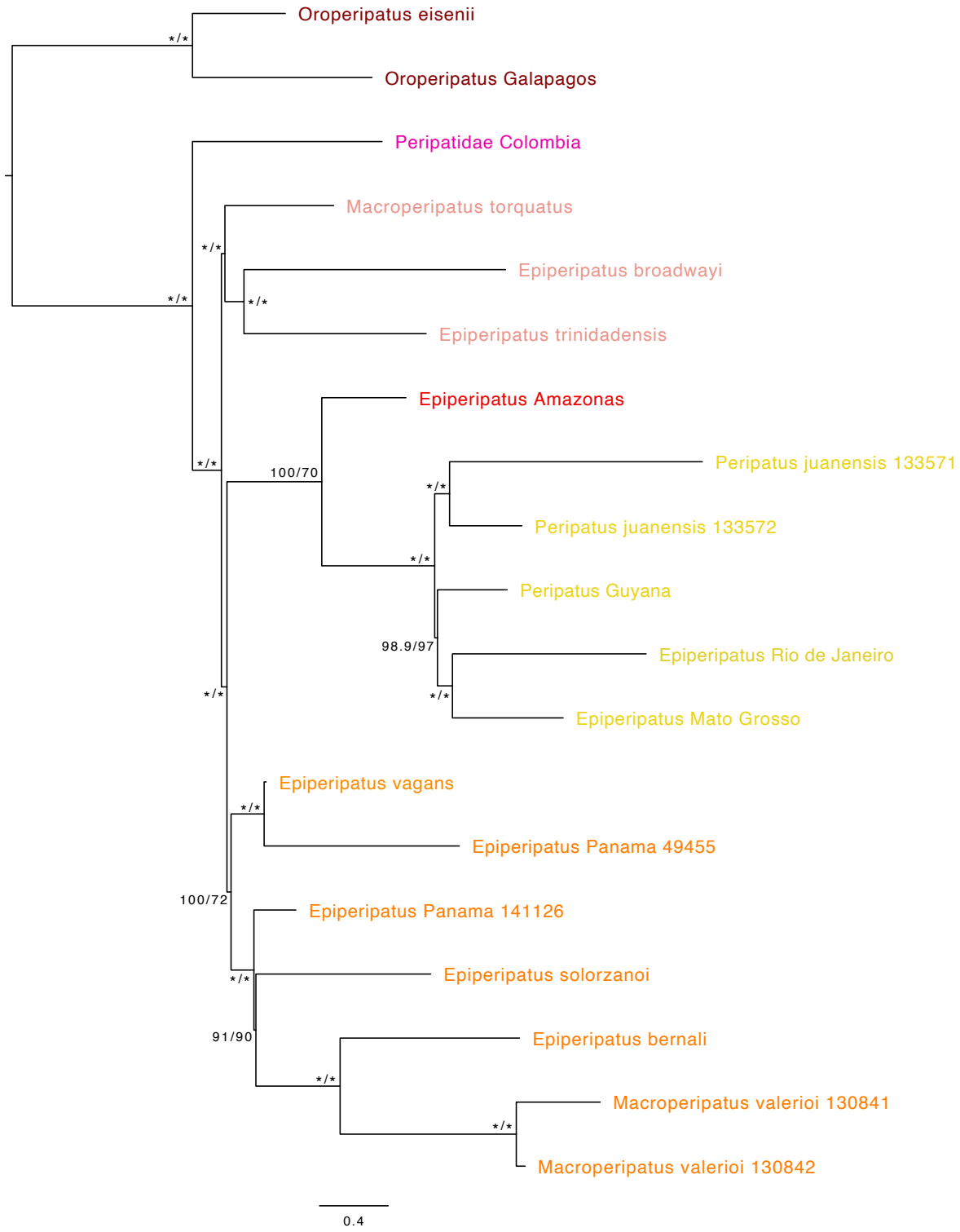

Figure S18. Phylogeny of Neopatida inferred from IQ-TREE analysis of M6. Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

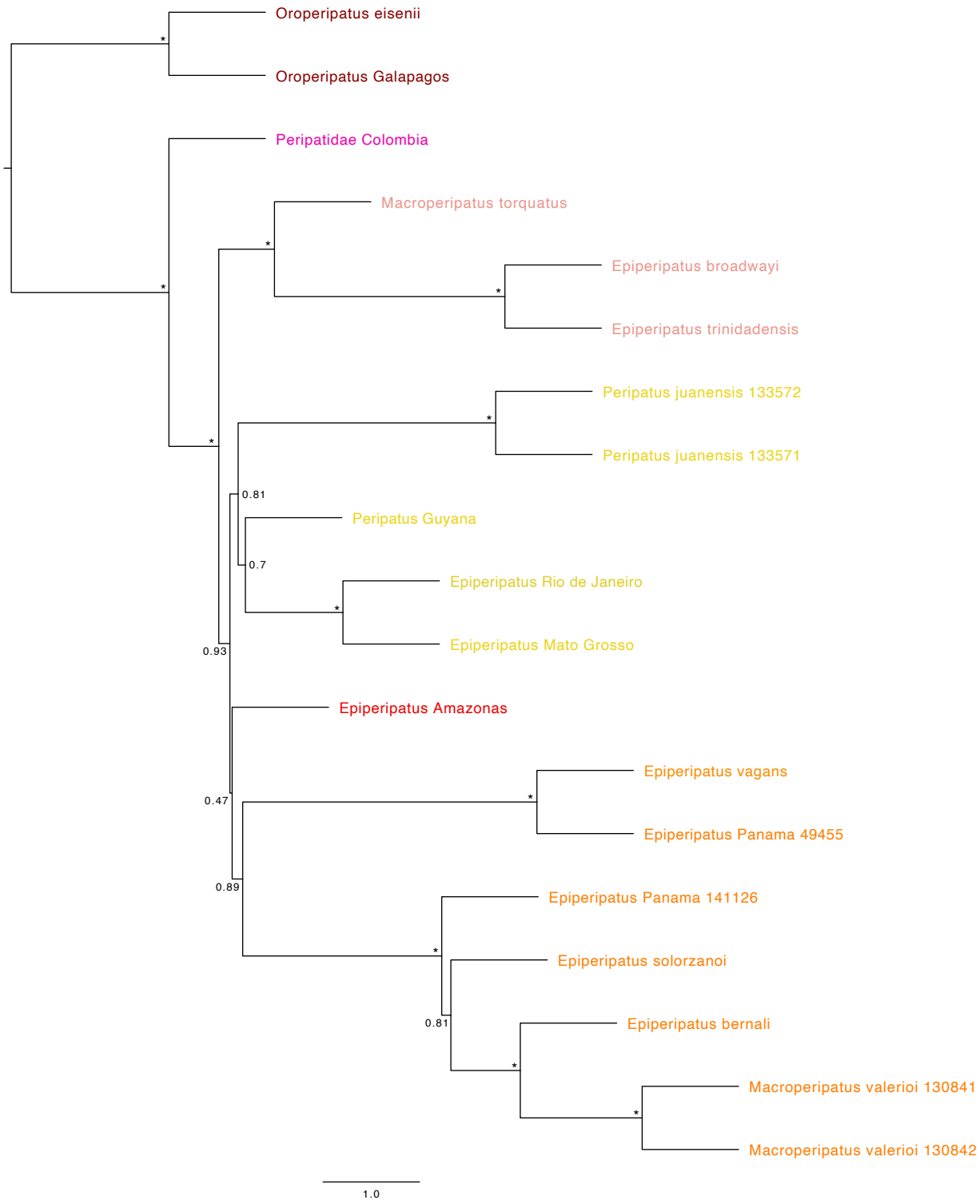

Figure S19. Phylogeny of Neopatida inferred from ASTRAL analysis of M6. Asterisks (*) mark nodes with full support; remaining nodes show local posterior probabilities.

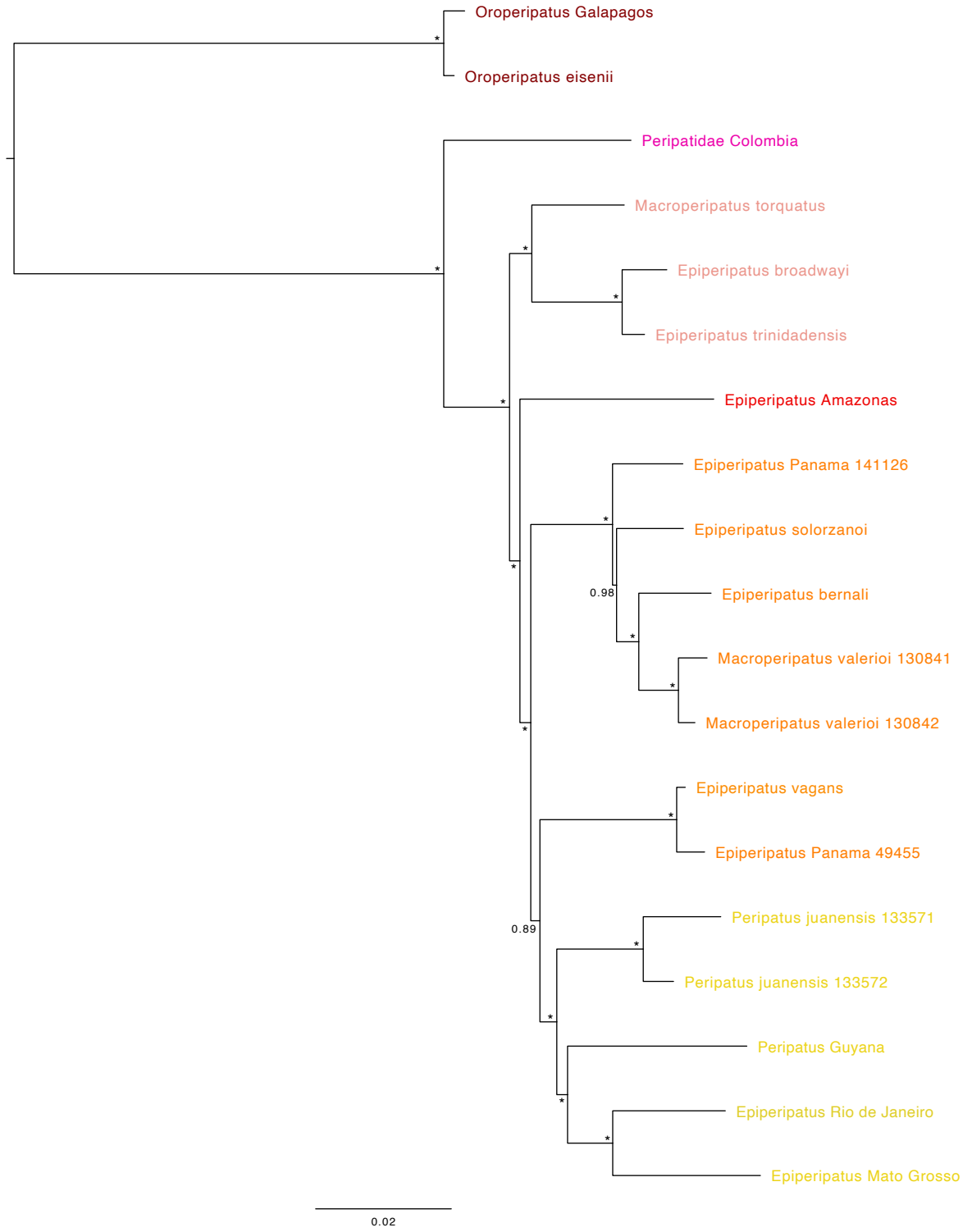

Figure S20. Phylogeny of Neopatida inferred from ExaBayes analysis of M6. Asterisks (*) mark nodes with full support; remaining nodes show the posterior probability.

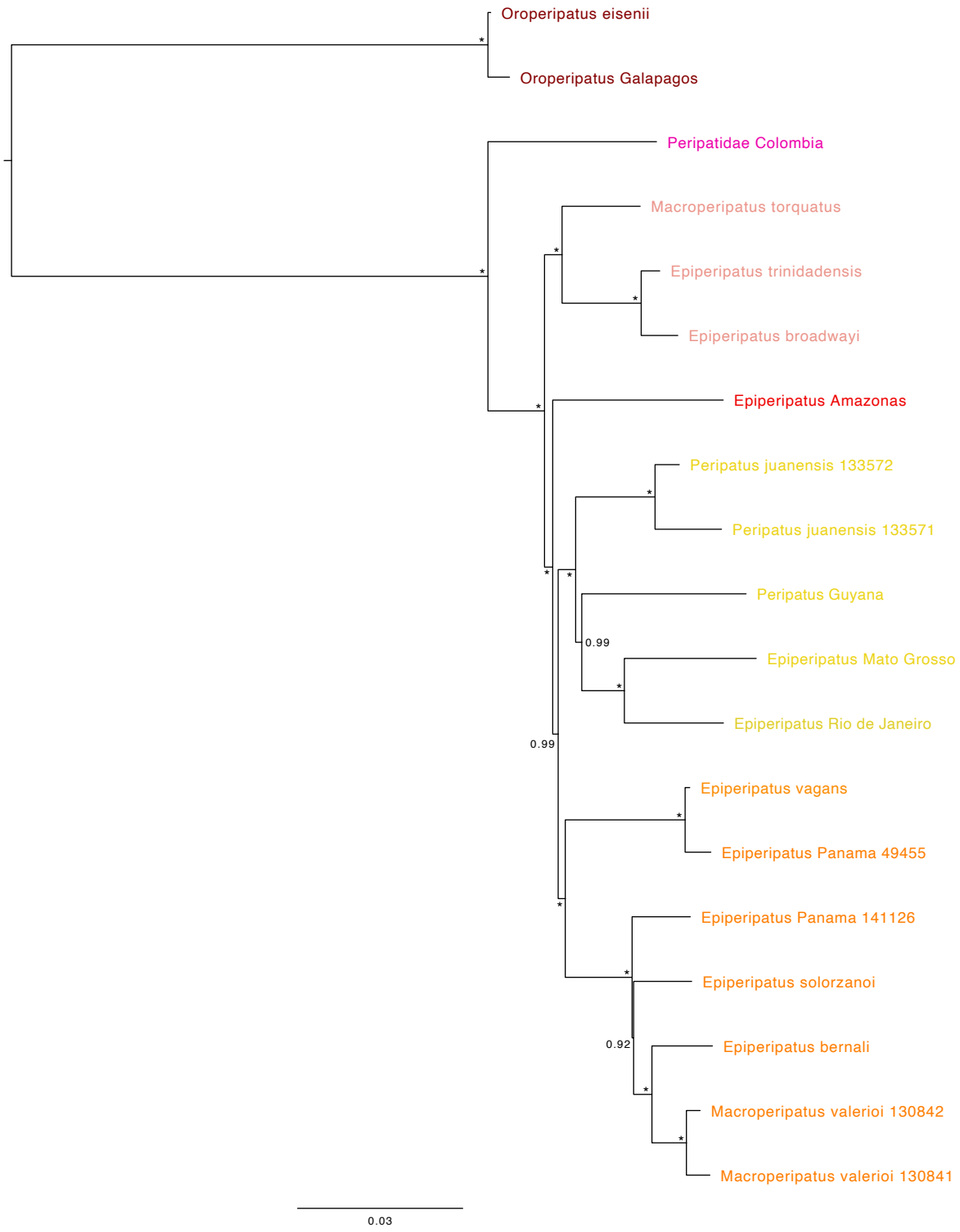

Figure S21. Phylogeny inferred from PhyloBayes analysis of M6. Asterisks (*) mark nodes with full support; remaining nodes show the posterior probability.

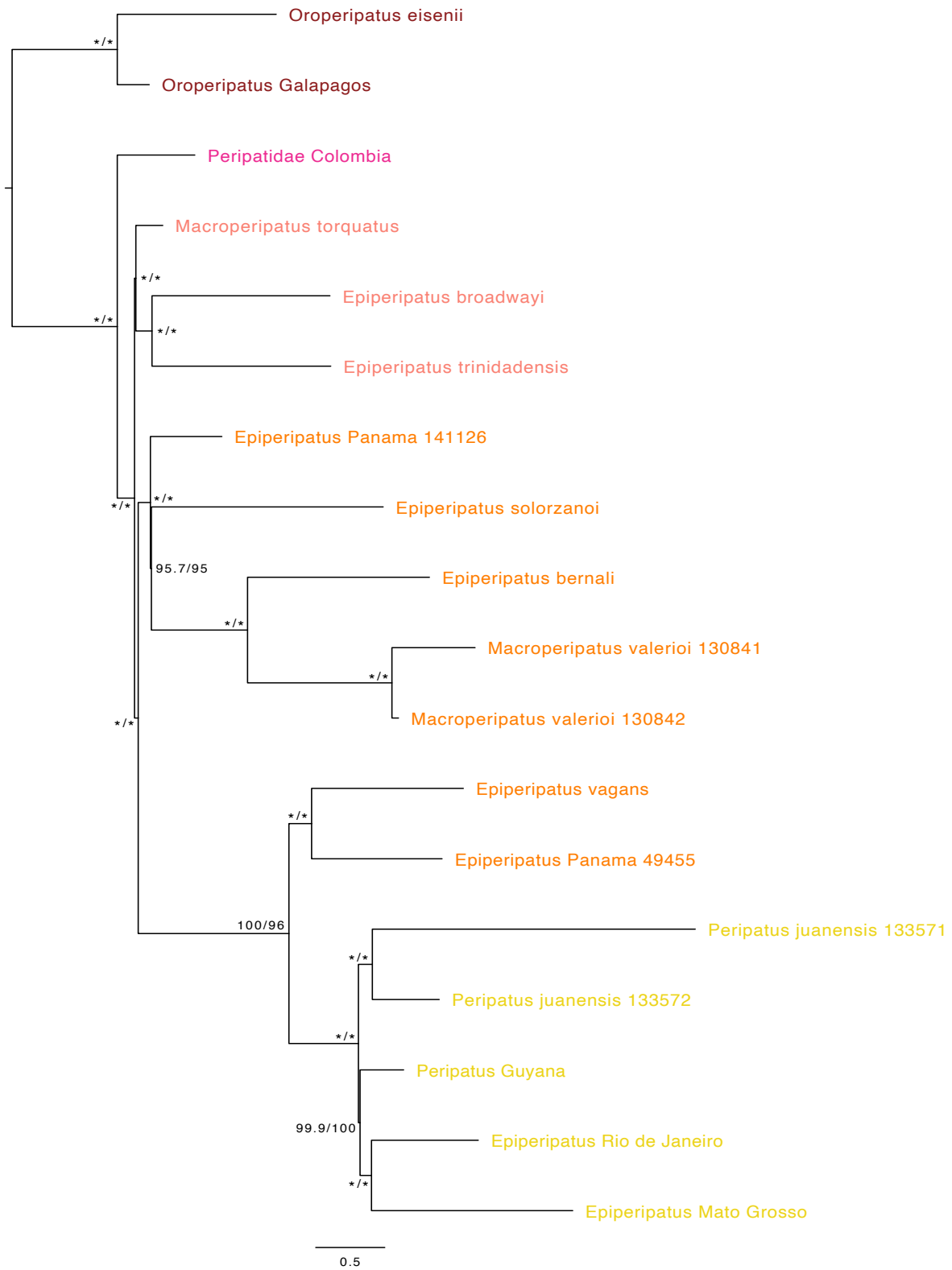

Figure S22. Phylogeny inferred from IQ-TREE analysis of M6, excluding *Epiperipatus* sp. Amazonas (MCZ-136557). Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

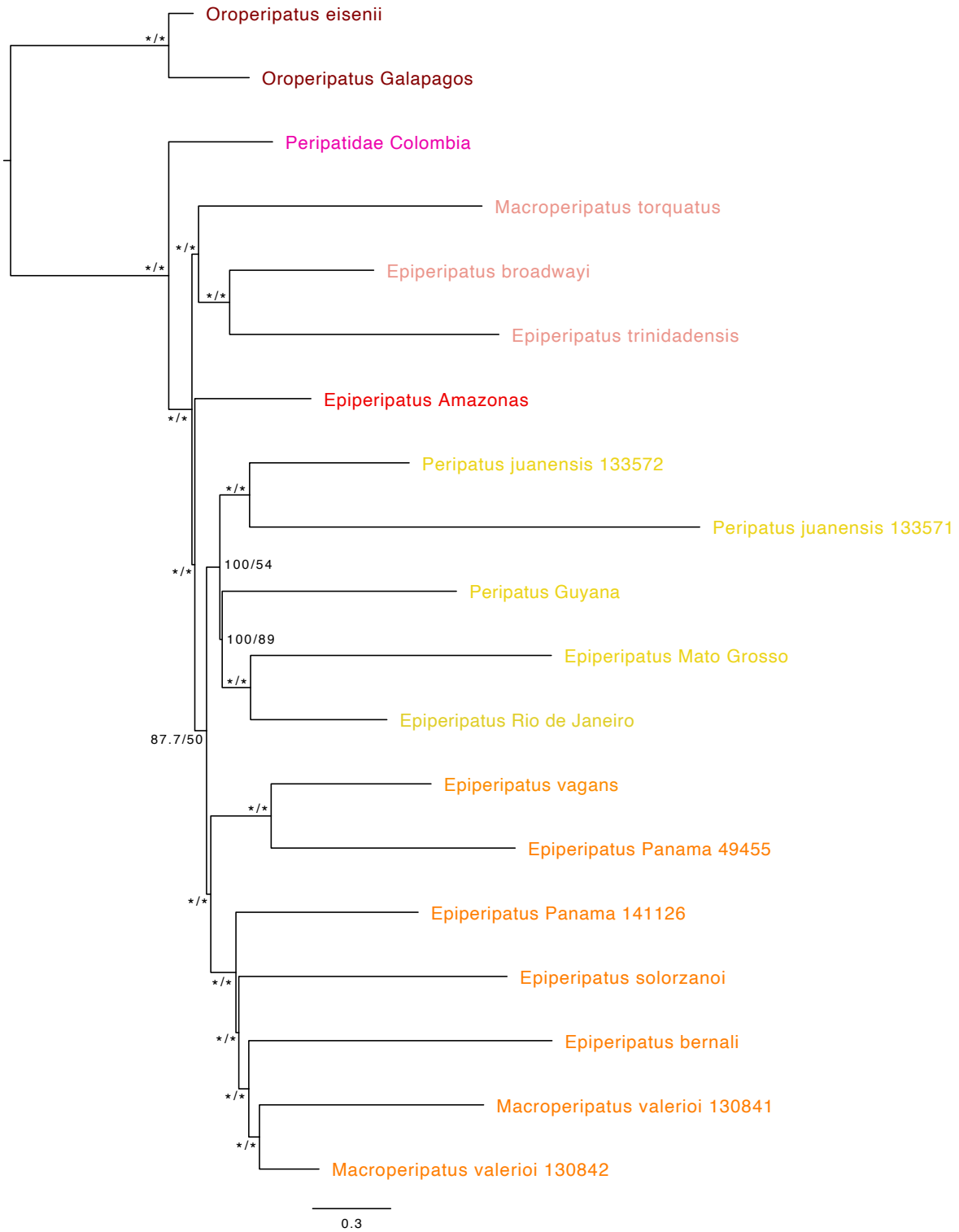

Figure S23. Phylogeny of Neopatida inferred from IQ-TREE analysis of M7. Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

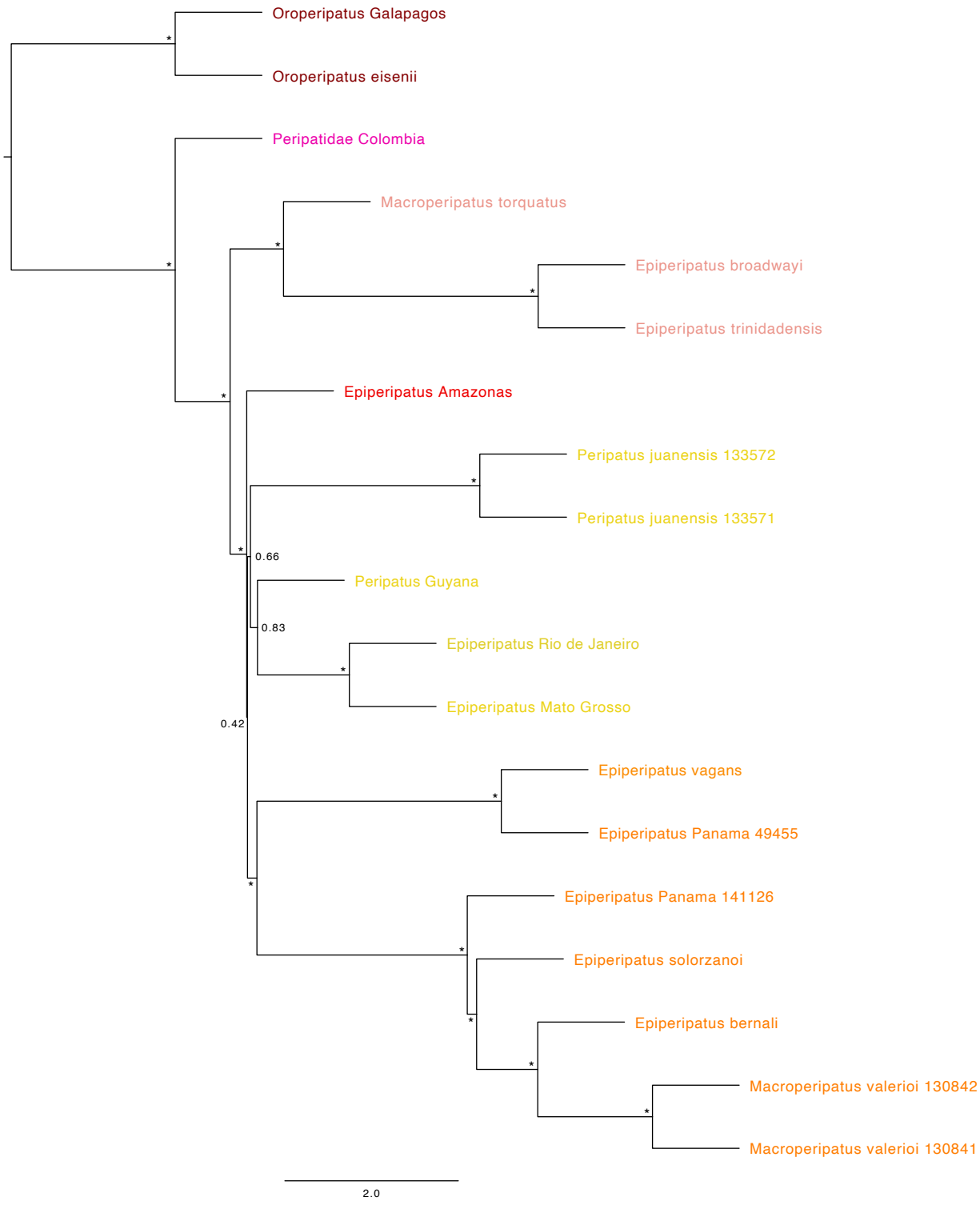

Figure S24. Phylogeny of Neopatida inferred from ASTRAL analysis of M7. Asterisks (*) mark nodes with full support; remaining nodes show local posterior probabilities.

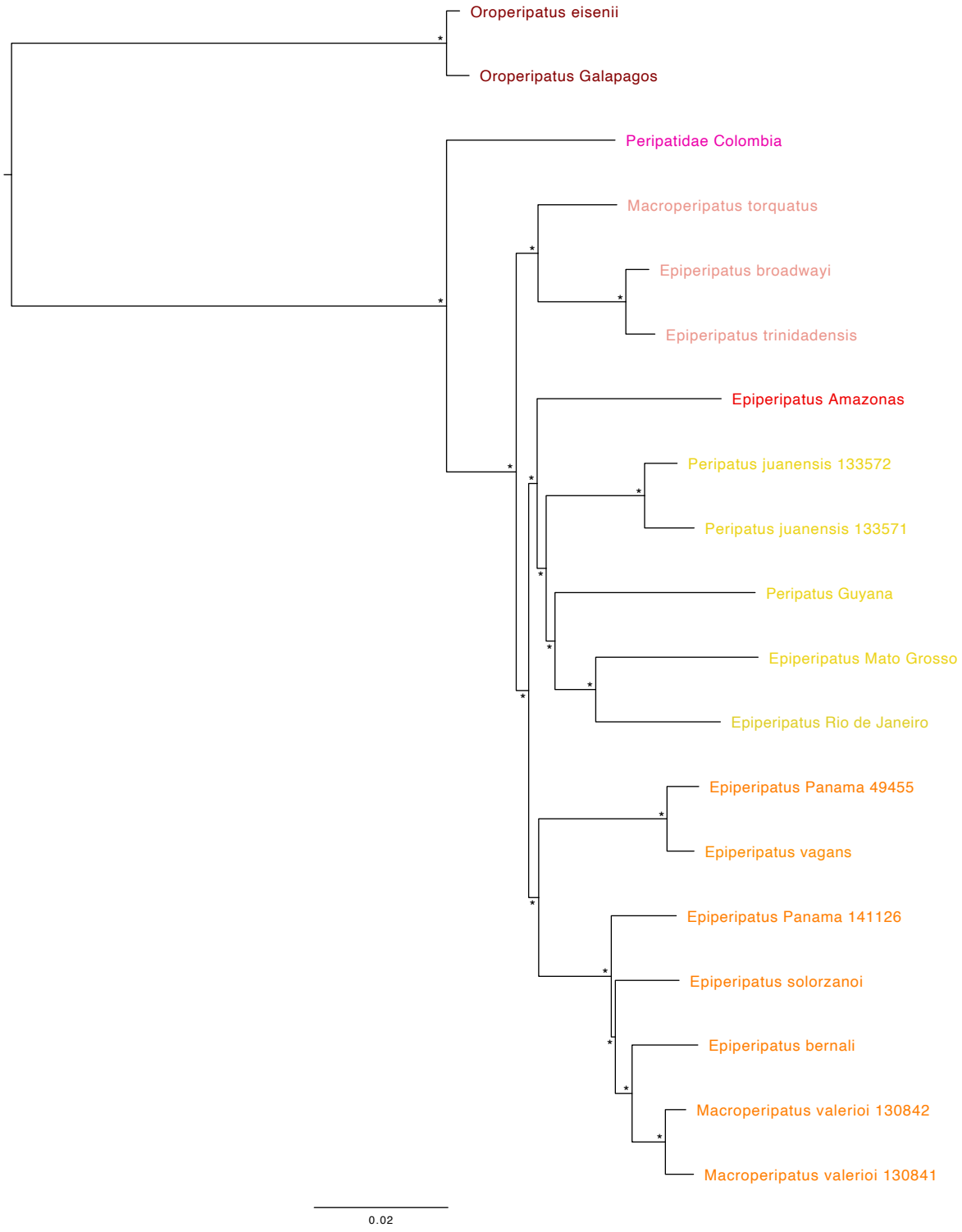

Figure S25. Phylogeny of Neopatida inferred from ExaBayes analysis of M7. Asterisks (*) mark nodes with full support.

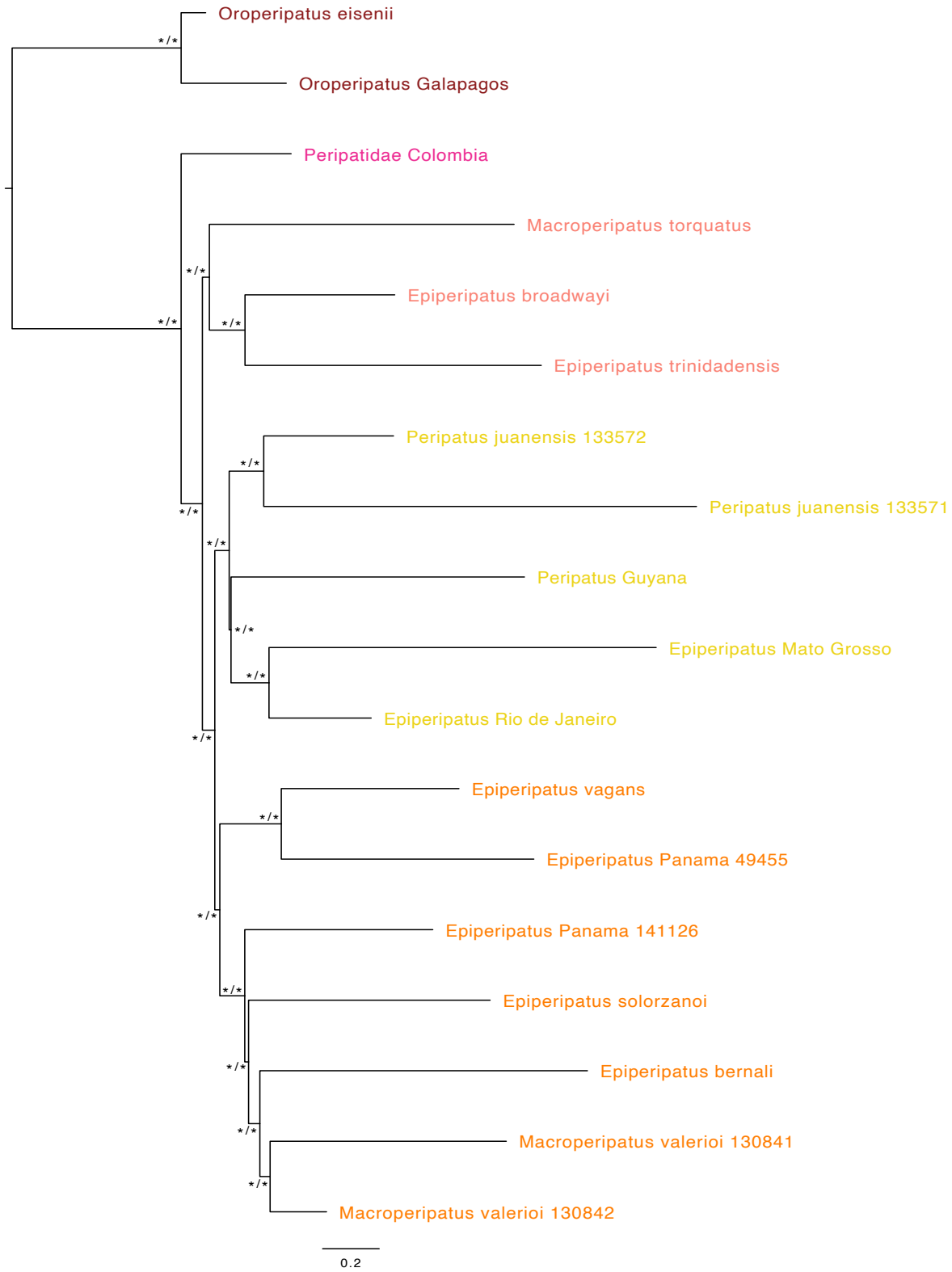

Figure S26. Phylogeny inferred from IQ-TREE analysis of M7, excluding *Epiperipatus* sp. Amazonas (MCZ-136557). Asterisks (*) mark nodes with full support.

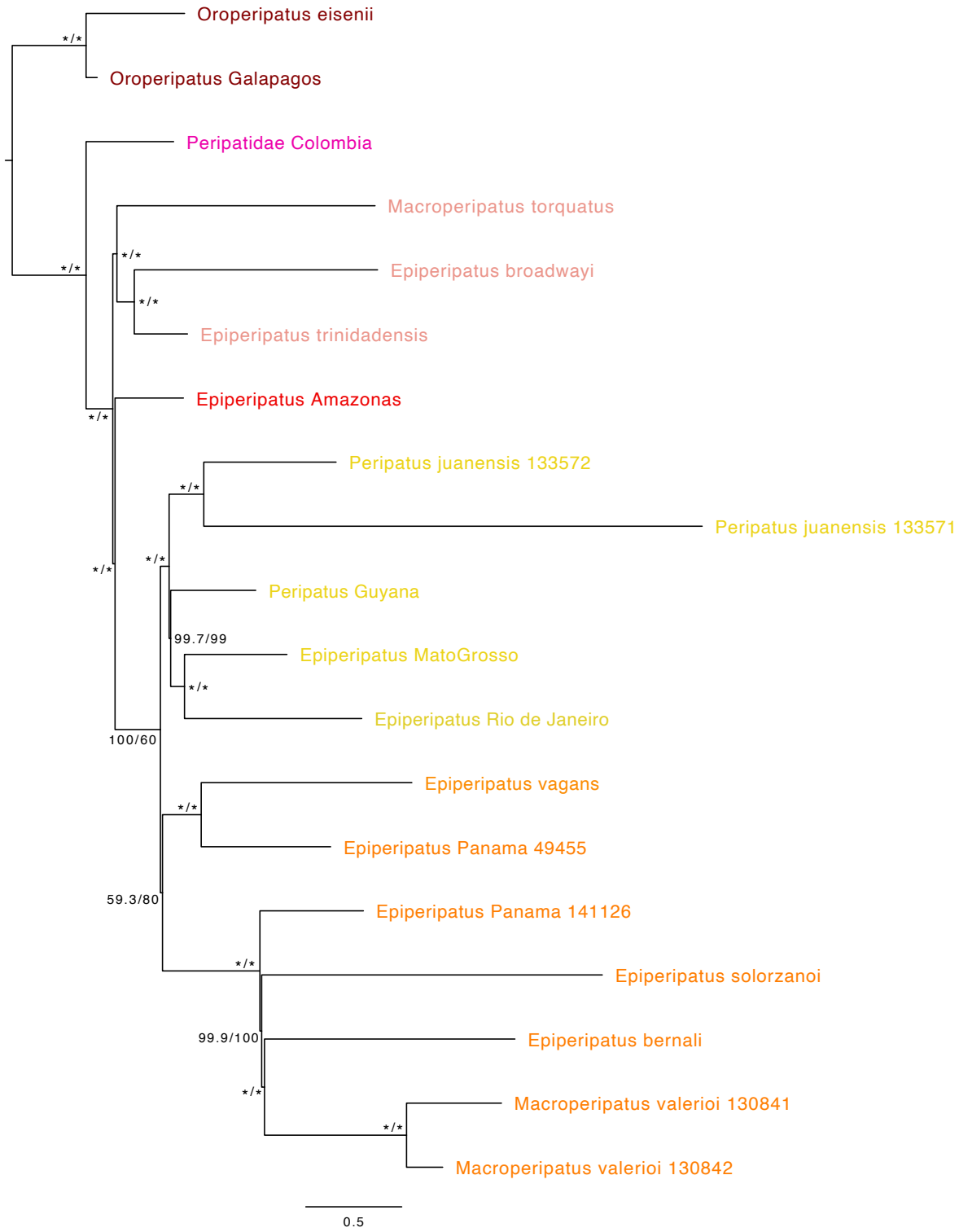

Figure S27. Phylogeny of Neopatida inferred from IQ-TREE analysis of M8. Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

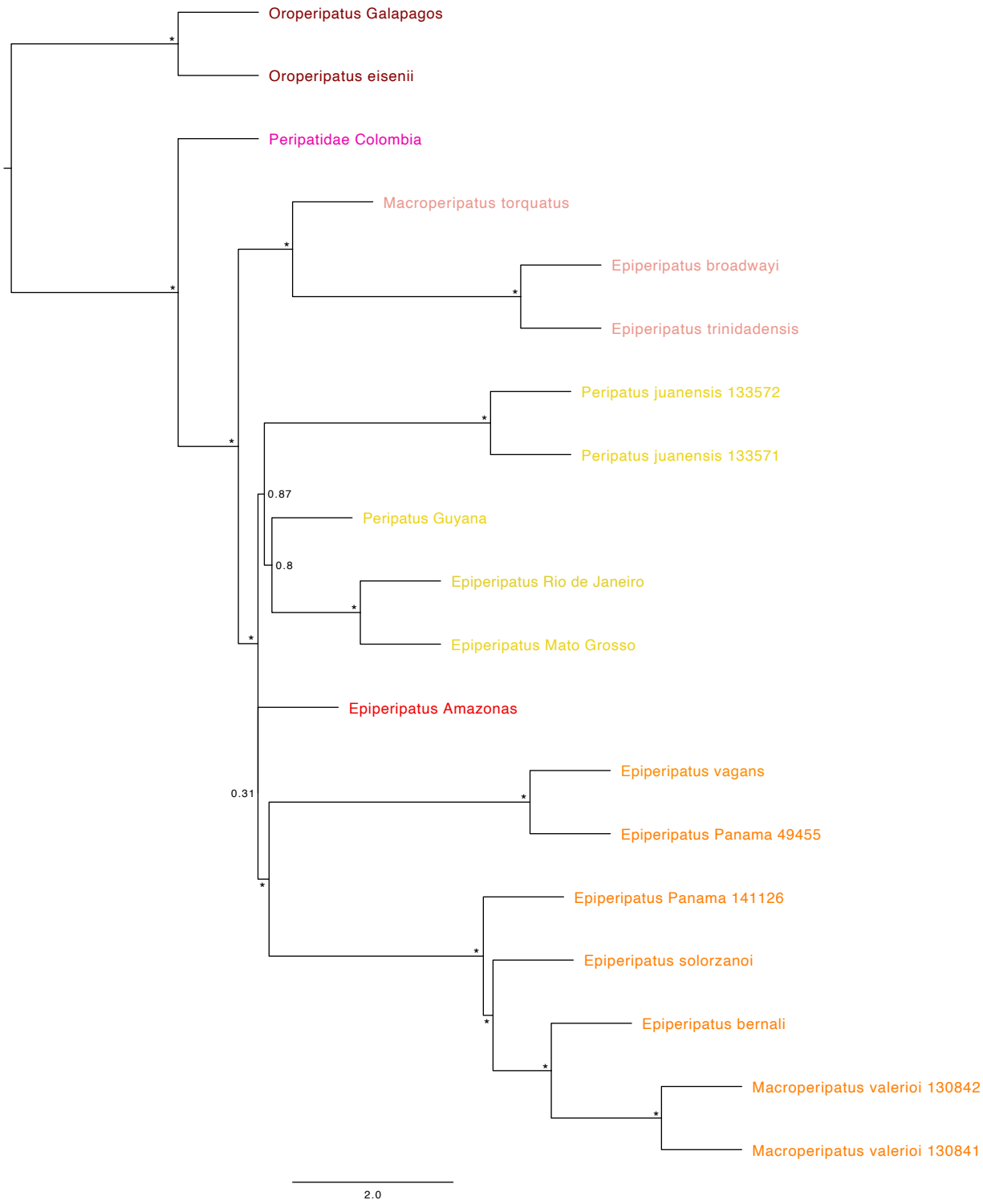

Figure S28. Phylogeny of Neopatida inferred from ASTRAL analysis of M8. Asterisks (*) mark nodes with full support; remaining nodes show local posterior probabilities.

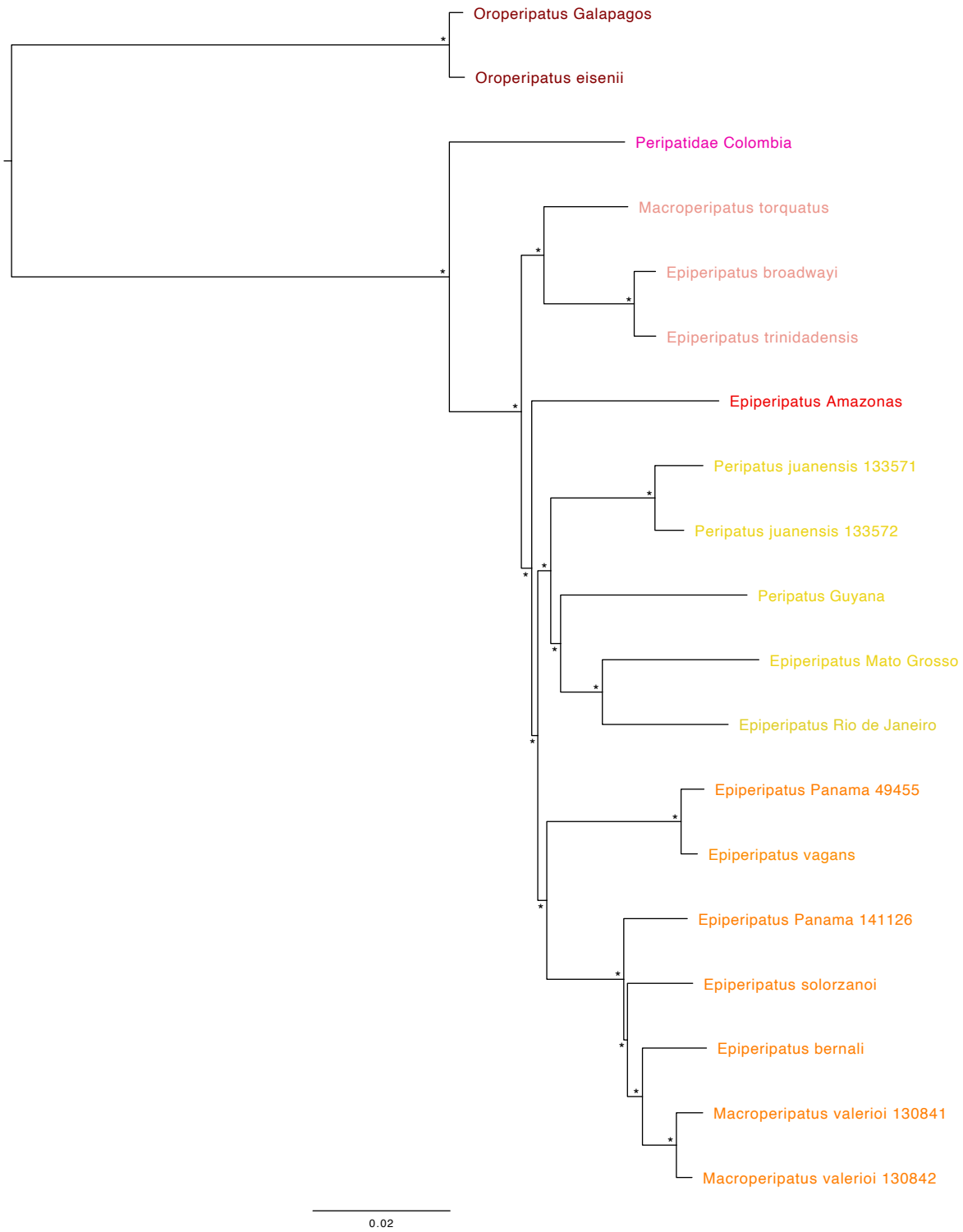

Figure S29. Phylogeny of Neopatida inferred from ExaBayes analysis of M8. Asterisks (*) mark nodes with full support.

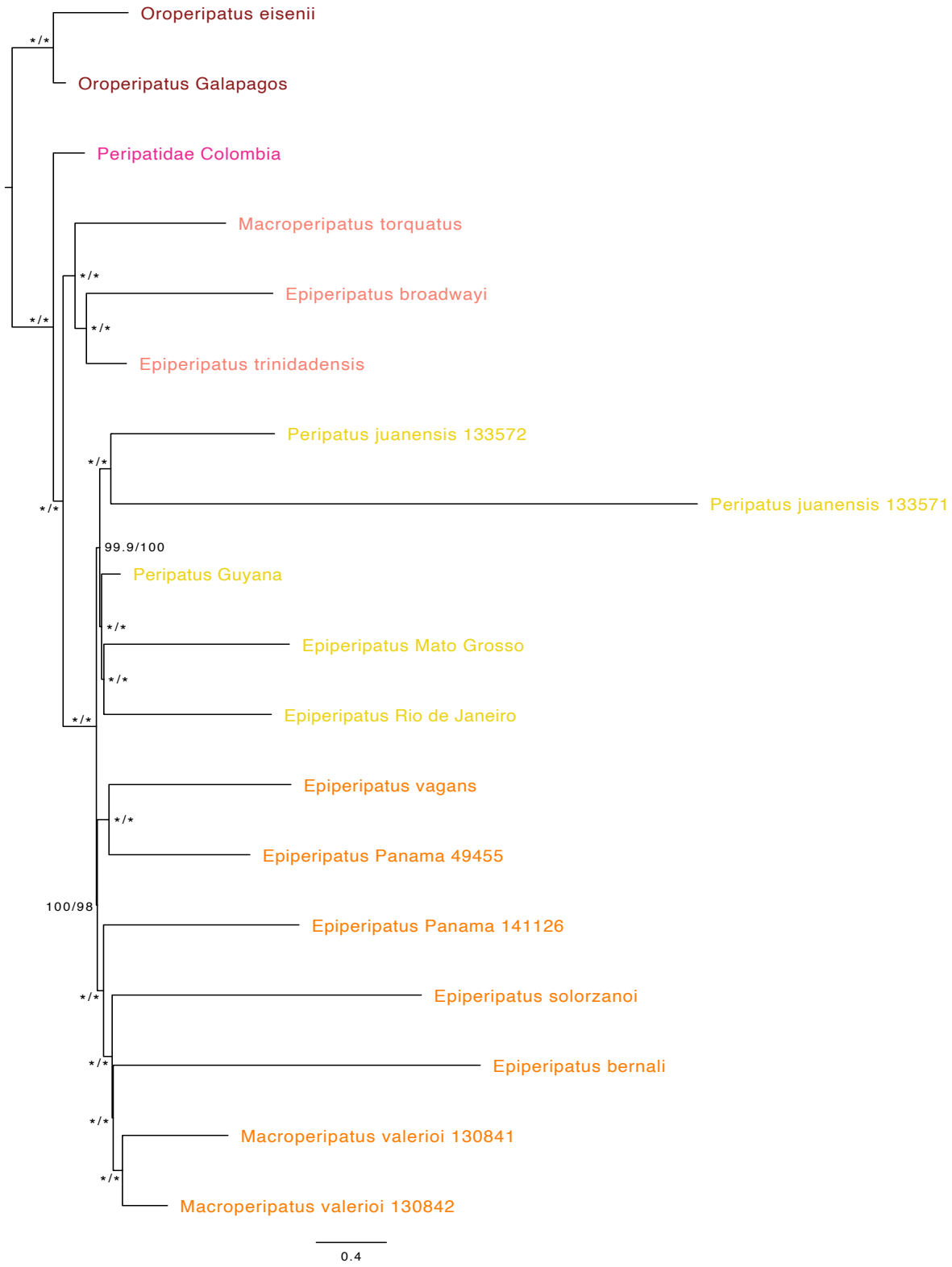

Figure S30. Phylogeny inferred from IQ-TREE analysis of M8, excluding *Epiperipatus* sp. Amazonas (MCZ-136557). Asterisks (*) mark nodes with full support; remaining nodes show the Shimodaira-Hasegawa approximate likelihood ratio test and ultrafast bootstrap support values.

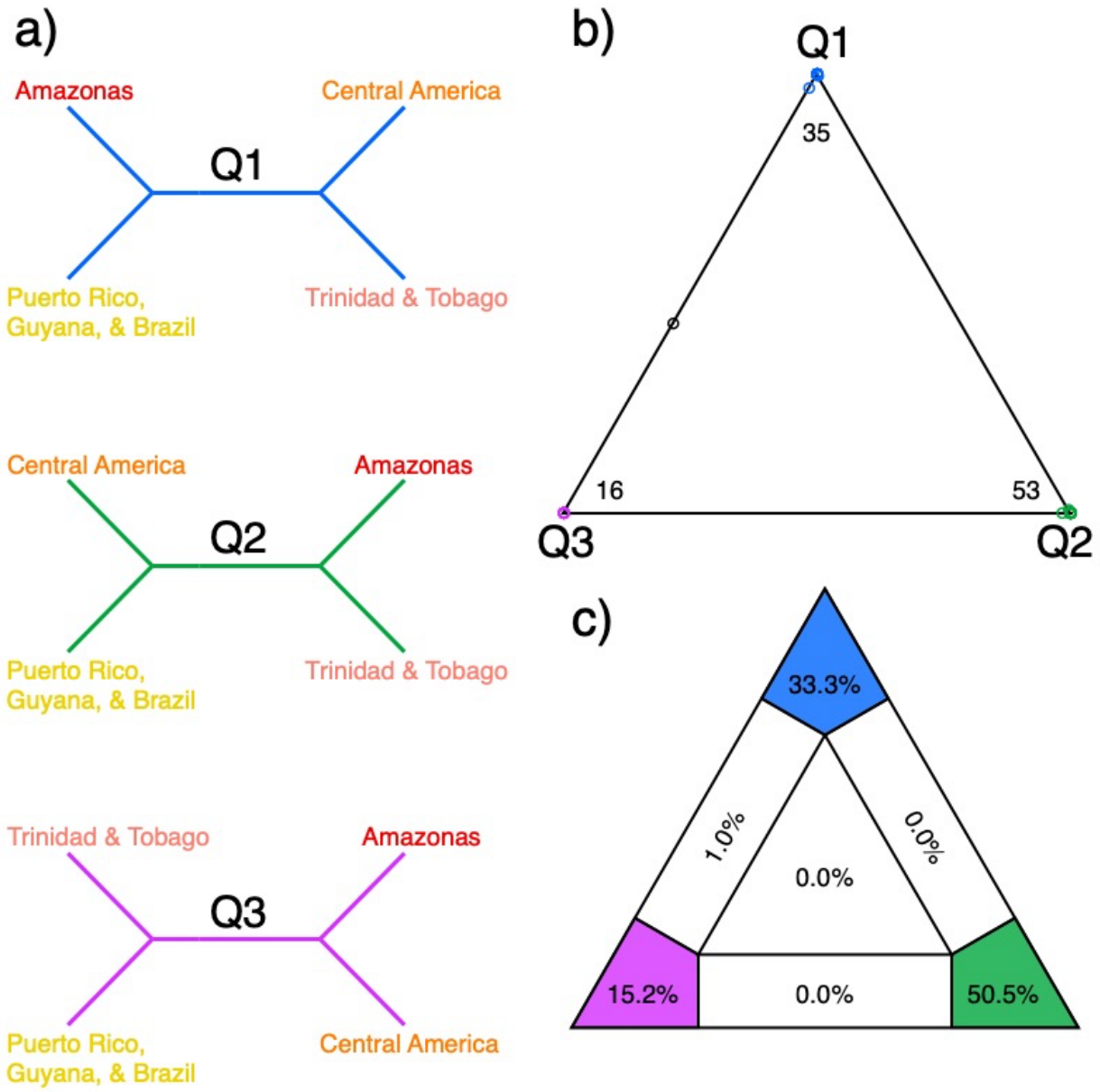

Figure S31. Results of the quartet likelihood mapping analysis performed on M5. (a) The three possible topologies for our four predefined groups from the Neotropics. (b) Number of quartets that support each of the three possible topologies. Points coloured by which topology they support, coloured as in (a). (c) Percentage of quartets that support each of the possible topologies, with regions of the graph differentiated according to how well a quartet falling in that region can answer a phylogenetic hypothesis.

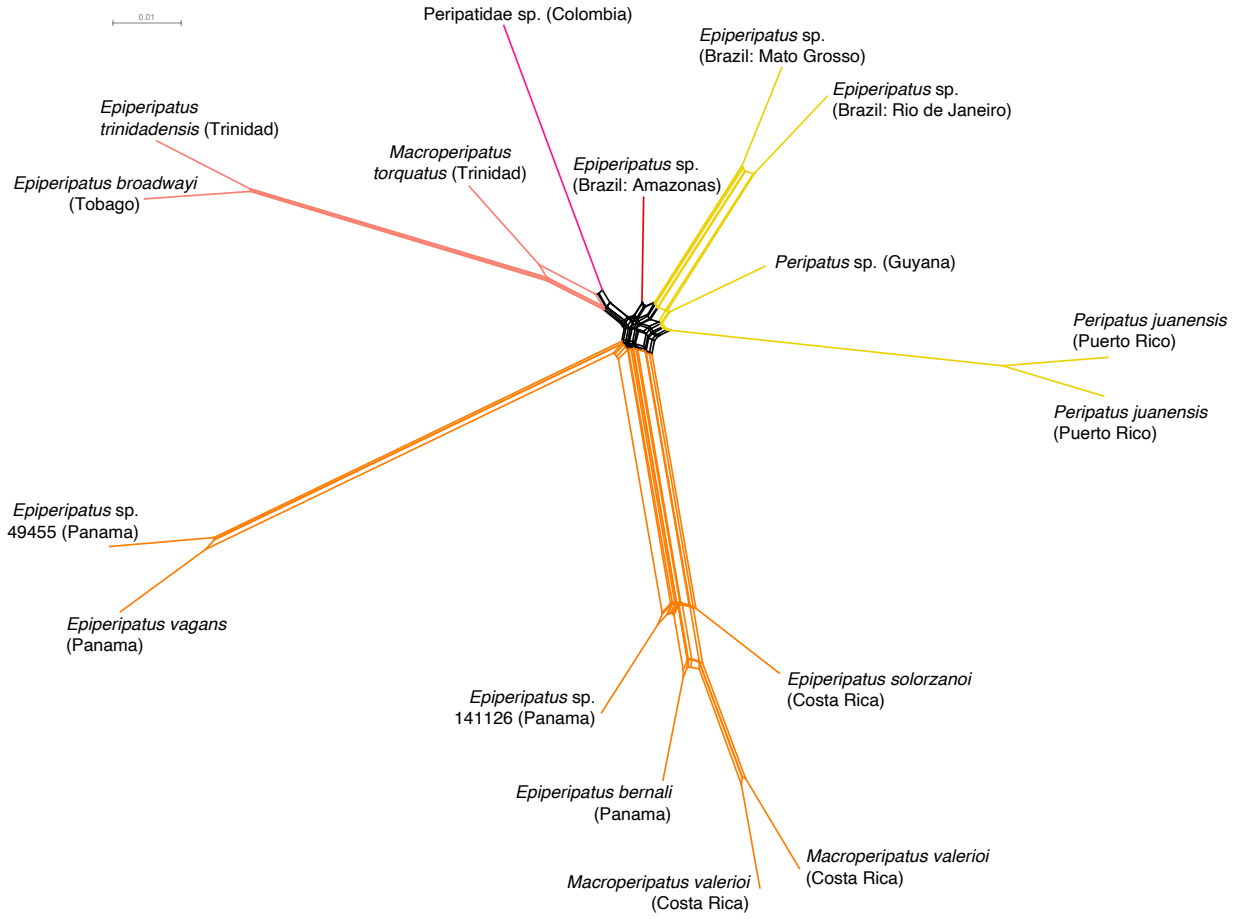

Figure S32. Quartet supernetwork built from 1,147 individual gene trees (M5) in SuperQ, showing conflicting signal between genes. *Oroperipatus eisenii* and *Oroperipatus* sp. Galapagos filtered out for visual clarity. Edges scaled according to bipartition frequency, with specific edges coloured according to clade identity as in main text Figs. 1-3.

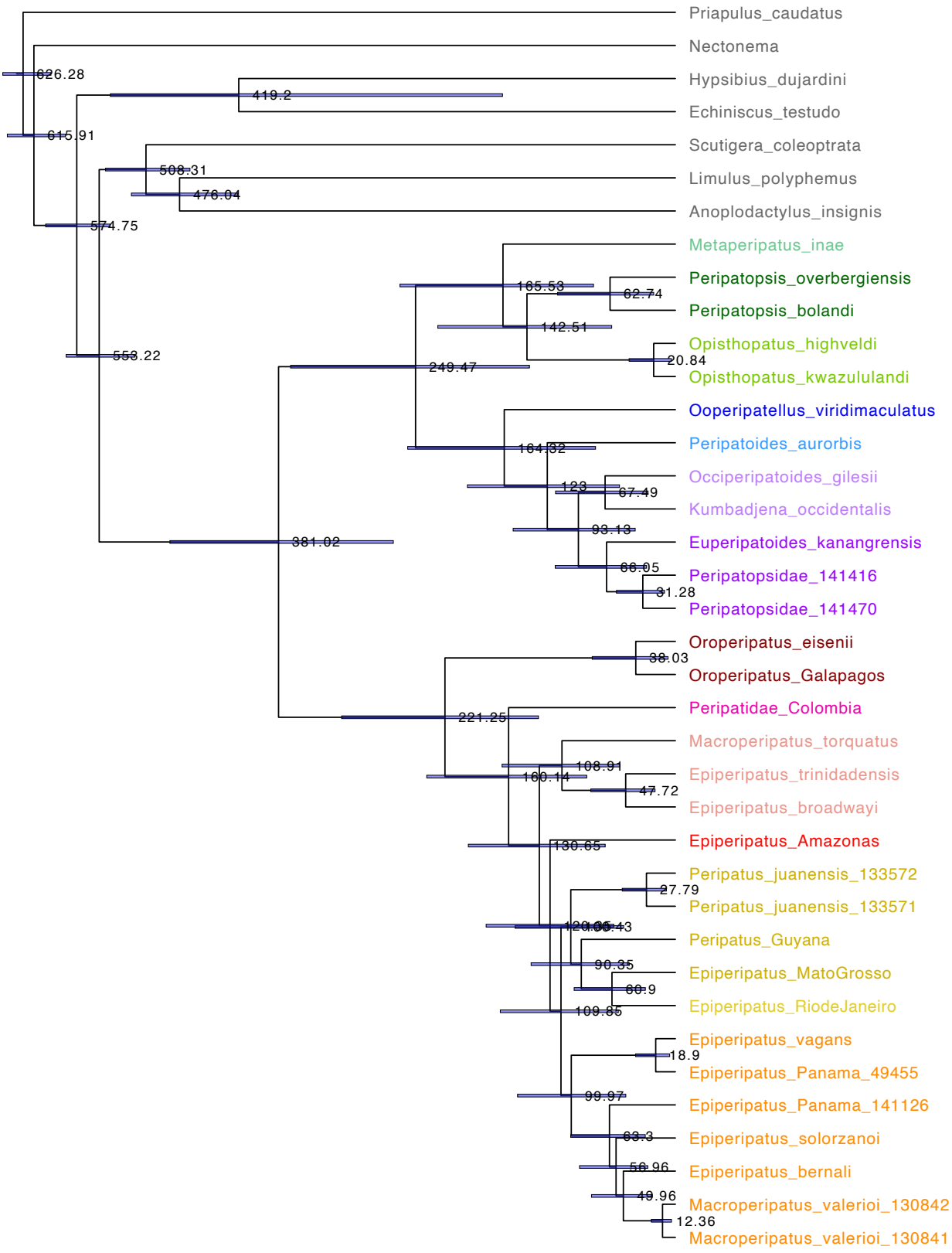

Figure S33. Chronogram inferred in MCMCTree, specifying no constraint on the age of Onychophora. Numbers at nodes show mean node ages, bars show 95% HPD of age estimates.

Table S1. Collection and accession information for onychophoran specimens used in this study. Newly sequenced samples are shown in bold. M3 refers to matrix 3 (see Table S3). BUSCO completeness scores are for the Metazoa database.

Species	MCZ IZ Catalog #	SRA number	Country	BUSCO	Loci in M3	Latitude	Longitude	Collection date	Source
Family Peripatidae									
Epiperipatus sp.	136557	SRR8627713	Brazil (Amazonas)	38.45%	993	-2.9295	-59.9756	18-Dec-2013	(Laumer et al. 2019)
Epiperipatus sp.	**141132**	**SRR13614443**	**Brazil (Mato Grosso)**	**42.02%**	**844**	**-15.4407**	**-55.7704**	**23-Dec-2014**	**this study**
Epiperipatus sp.	**141131**	**SRR13614439**	**Brazil (Rio de Janeiro)**	**42.84%**	**947**	**-22.4588**	**-42.6534**	**21-Dec-2014**	**this study**
Peripatidae sp.	**141458**	**SRR13614444**	**Colombia**	**68.61%**	**1016**	**5.8806**	**-73.0640**	**4-Dec-2016**	**this study**
Macroperipatus valerioi	**130841**	**SRR13614428**	**Costa Rica**	**39.78%**	**962**	**9.4885**	**-83.9568**	**13-Jul-2015**	**this study**
Macroperipatus valerioi	**130842**	**SRR13614427**	**Costa Rica**	**14.83%**	**436**	**9.4838**	**-83.9396**	**8-Jul-2015**	**this study**
Epiperipatus solorzanoi	**130840**	**SRR13614434**	**Costa Rica**	**40.18%**	**829**	**9.6731**	**-83.0243**	**14-Jun-2015**	**this study**
Oroperipatus sp.	**133614**	**SRR13614445**	**Galapagos**	**9.82%**	**410**	**-0.6249**	**-90.3855**	**Feb-2016**	**this study**
Peripatus sp.	**46445**	**SRR13614437**	**Guyana**	**10.53%**	**617**	**4.1514**	**-58.2146**	**22-Sep-2014**	**this study**
Oroperipatus eisenii	**74293**	**SRR13614446**	**Mexico**	**46.63%**	**836**	**21.4794**	**-105.0776**	**Nov-2015**	**this study**
Epiperipatus sp.	**49455**	**SRR13614425**	**Panama**	**14.01%**	**725**	**8.7916**	**-78.4524**	**19-Jan-2015**	**this study**
Epiperipatus sp.	141126	SRR8320992	Panama	77.61%	936	8.7467	-82.4189	9-Sep-2014	(Mapalo et al. 2020)
Epiperipatus vagans	**141130**	**SRR13614432**	**Panama**	**67.48%**	**1046**	**9.0836**	**-79.6632**	**14-Sep-2014**	**this study**
Epiperipatus bernali	**141128**	**SRR13614442**	**Panama**	**64.72%**	**904**	**8.4332**	**-82.4519**	**10-Sep-2014**	**this study**
Peripatus juanensis	**133571**	**SRR13614436**	**Puerto Rico**	**6.65%**	**579**	**18.1720**	**-67.0445**	**12-Feb-2016**	**this study**
Peripatus juanensis	**133572**	**SRR13614435**	**Puerto Rico**	**9.61%**	**658**	**18.3232**	**-65.8155**	**19-Feb-2016**	**this study**
Epiperipatus broadwayi	**143935**	**SRR13614426**	**Trinidad & Tobago (Tobago)**	**67.69%**	**975**	**11.2869**	**-60.6101**	**26-May-2017**	**this study**

Epiperipatus trinidadensis	143926	SRR13614433	Trinidad & Tobago (Trinidad)	69.02%	1048	10.7051	-61.2898	16-May-2017	this study
Macroperipatus torquatus	143928	SRR13614429	Trinidad & Tobago (Trinidad)	62.78%	1013	10.7459	-61.2554	16-May-2017	this study
Family Peripatopsidae									
Euperipatoides kanangrensis	**131395**	**SRR13614431**	**Australia (NSW)**	**16.87%**	**178**	**-33.9833**	**150.1333**	**—**	**this study**
Peripatopsidae sp.	**141470**	**SRR13614440**	**Australia (QLD)**	**61.25%**	**898**	**-27.3917**	**152.9236**	**22-Oct-2016**	**this study**
Peripatopsidae sp.	**141416**	**SRR13614441**	**Australia (QLD)**	**67.28%**	**1008**	**-24.4130**	**151.0387**	**25-May-2015**	**this study**
Kumbadjena occidentalis	141468	SRR13614430	Australia (WA)	42.43%	551	-33.9078	115.0136	10-Jan-2016	this study
Occiperipatoides gilesii	141469	SRR13614423	Australia (WA)	48.16%	846	-31.8667	116.0667	27-Jul-2016	this study
Metaperipatus inae	138078	SRR13614424	Chile	75.87%	1037	-38.0163	-73.1790	13-Nov-2014	this study
Ooperipatellus viridimaculatus	29203	SRR8627697	New Zealand	33.23%	708	-44.4876	168.7874	20-Jan-2014	(Laumer et al. 2019)
Peripatoides aurorbis	29204	SRR8627695	New Zealand	47.24%	867	-37.8419	174.7734	10-Jan-2014	(Laumer et al. 2019)
Opisthopatus kwazululandi	131434	SRR8318947	South Africa	82.62%	1025	-24.9370	31.3752	14-Nov-2011	(Mapalo et al. 2020)
Opisthopatus highveldi	**131328**	**SRR13614447**	**South Africa**	**21.17%**	**257**	**-28.7442**	**31.1376**	**4-Apr-2001**	**this study**
Peripatopsis bolandi	**49527**	**SRR13614438**	**South Africa**	**79.75%**	**1005**	**-34.0047**	**18.9944**	**26-Dec-2014**	**this study**
Peripatopsis overbergiensis	131372	SRR1145776	South Africa	51.94%	963	-33.9819	20.8231	17-Apr-2009	(Sharma et al. 2014)

Table S2. Outgroup taxa used in phylogenetic analysis of M1 and M2.

Phylum	**Species**	**SRA number**	**Source**
Priapulida	*Priapulus caudatus*	---	(Kocot et al. 2017)
Nematomorpha	*Nectonema munidae*	SRR8618616	(Laumer et al. 2019)
Tardigrada	*Echiniscus testudo*	SAMN10601501–SAMN10601521	(Mapalo et al. 2020)
Tardigrada	*Hypsibius dujardini*	---	(Yoshida et al. 2017)
Arthropoda	*Scutigera coleoptrata*	SRR1158078	(Fernández et al. 2014)
Arthropoda	*Limulus polyphemus*	SRR1145732	(Sharma et al. 2014)
Arthropoda	*Anoplodactylus insignis*	SRR5237777	(Fernández et al. 2016)

Table S3. Percentage of loci sampled in Neopatida-specific matrices M5–M8 across taxa. New transcriptomes in bold. See main text for details.

Species	MCZ Catalog #	Country	M5 %	M6 %	M7 %	M8 %
Oroperipatus eisenii	**74293**	**Mexico**	**0.73**	**0.93**	**0.73**	**0.75**
***Oroperipatus* sp.**	**133614**	**Ecuador (Galapagos)**	**0.27**	**0.66**	**0.28**	**0.26**
Peripatidae sp.	**141458**	**Colombia**	**0.86**	**0.94**	**0.87**	**0.87**
Epiperipatus trinidadensis	**143926**	**Trinidad & Tobago (Trinidad)**	**0.89**	**0.91**	**0.89**	**0.91**
Epiperipatus broadwayi	**143935**	**Trinidad & Tobago (Tobago)**	**0.85**	**0.87**	**0.85**	**0.85**
Macroperipatus torquatus	**143928**	**Trinidad & Tobago (Trinidad)**	**0.87**	**0.91**	**0.87**	**0.88**
Epiperipatus sp.	136557	Brazil (Amazonas)	0.73	0.9	0.73	0.73
***Epiperipatus* sp.**	**141131**	**Brazil (Rio de Janeiro)**	**0.75**	**0.93**	**0.76**	**0.76**
***Epiperipatus* sp.**	**141132**	**Brazil (Mato Grosso)**	**0.56**	**0.73**	**0.56**	**0.58**
***Peripatus* sp.**	**46445**	**Guyana**	**0.28**	**0.74**	**0.28**	**0.28**
Peripatus juanensis	**133572**	**Puerto Rico**	**0.32**	**0.79**	**0.32**	**0.3**
Peripatus juanensis	**133571**	**Puerto Rico**	**0.2**	**0.58**	**0.2**	**0.19**
Epiperipatus sp.	141126	Panama	0.8	0.86	0.8	0.8
Epiperipatus vagans	**141130**	**Panama**	**0.76**	**0.84**	**0.77**	**0.79**
Epiperipatus bernali	**141128**	**Panama**	**0.78**	**0.82**	**0.79**	**0.78**
Epiperipatus solorzanoi	**130840**	**Costa Rica**	**0.77**	**0.92**	**0.77**	**0.77**
Macroperipatus valerioi	**130841**	**Costa Rica**	**0.78**	**0.91**	**0.78**	**0.79**
Macroperipatus valerioi	**130842**	**Costa Rica**	**0.42**	**0.88**	**0.42**	**0.4**
***Epiperipatus* sp.**	**49455**	**Panama**	**0.39**	**0.8**	**0.39**	**0.37**

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