

Supplementary material for “Reconstructing the evolution of Indo-European grammar”

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Appendices

Here, we describe the process used to generate the tree sample used for inference in this paper, as well as the details of the inference process used to infer evolutionary transition rates and estimate the probabilities of typological states at unobserved nodes in our tree such as the root (corresponding to Proto-Indo-European). All code is available at <https://github.com/chundrac/rec-evo-IE-gram> and <https://zenodo.org/record/4275010>.

A Tree Sample

We assume a fixed topology (i.e. branching structure) for the Indo-European languages, informed by the comparative-historical *communis opinio*, as well as recent work on computational phylogenetic methods (cf. Chang et al. 2015), but incorporate uncertainty over branch lengths in the tree in the manner described below. For each tip (i.e. a vertex of the tree where data are observed, or an attested language) or node (i.e. a vertex of the tree where data are not observed, or a proto-language) in tree topology, we establish an upper and lower bound for the date of attestation each language or proto-language, in years before present; in the case of proto-languages, these dates are informed by existing computational phylogenetic work (e.g. Bouckaert et al. 2012; Chang et al. 2015) and carefully selected termini post quem and termini ante quem based on the historical and archaeological record. The following process is carried out in order to generate a tree with stochastically sampled branch lengths:

Starting at the root, we sample a value $\text{date}(\text{root}) \sim \text{Uniform}(\text{lower}(\text{root}), \text{upper}(\text{root}))$, where lower and upper refer to the lower and upper bounds established for possible dates of attestation for the root. Then subsequently, moving in pre-traversal order (i.e. from the

root of the tree to the tips), we sample a date for each remaining node from the uniform distribution, as follows:

$$\text{date}(\text{node}) \sim \text{Uniform}(\max(\text{date}(\text{parent}), \text{lower}(\text{node})), \text{upper}(\text{node}))$$

The above sampling statement ensures that all branch lengths are positive. From these sampled dates, we compute the length of the branch between a node n and its daughter d , $b(n, d)$, as follows:

$$b(nd) = \text{date}(n) - \text{date}(d)$$

This process is carried out 10000 times, yielding a tree sample. We scale our tree sample's branch lengths by dividing by 1000.

B Inference of Evolutionary Rates

For a given categorical feature with S states, there are $S(S - 1)$ possible transition types between different states. We assume that transitions between two different states follow a Continuous Time Markov process, parameterized by $S(S - 1)$ transition rates, which we write as \mathbf{R} . We place a $\text{Gamma}(1, 1)$ prior over each transition rate in \mathbf{R} ; the mean of this distribution is 1, corresponding to roughly one change per millennium. The posterior probability of the rates \mathbf{R} can be approximated as follows over an entire tree sample:

$$P(\mathbf{R}|D, \mathbf{T}) \propto P(D, \mathbf{R}|\mathbf{T}) = \sum_{T \in \mathbf{T}} P(D, \mathbf{R}|T)P(T|\mathbf{T}) \approx \frac{1}{|\mathbf{T}|} \sum_{T \in \mathbf{T}} P(D|T, \mathbf{R})P(\mathbf{R})$$

D refers to the observed data; \mathbf{T} denotes the tree sample, and T a single tree in the sample. The likelihood of a given tree and set of rates under the observed data, $P(D, \mathbf{R}|T)$, can be efficiently computed according to Felsenstein's Pruning Algorithm (Felsenstein 1981). Moving in post-traversal order (i.e. from the tips of the tree toward the root), the Pruning Algorithm calculates the likelihood of a given state s at an internal (i.e. non-tip) node n as follows:

$$\mathcal{L}(n = s) = \prod_{d \in d(n)} \left(\sum_{r \in S} \mathcal{L}(d = r) P_{sr}(b(n, d); \mathbf{R}) \right)$$

Above, $d(n)$ denotes the daughters of node n ; $b(a, b)$ denotes the length of the branch connecting nodes a and b (i.e. the displacement in time between two languages); $P_{sr}(t; \mathbf{R})$ denotes the probability of a transition from state s to state r over a time period of length t , given the rates \mathbf{R} . If data are attested at n , $\mathcal{L}(n = s)$ is either 1 or 0, depending on whether the state attested is s . If data are missing, $\mathcal{L}(n = s)$ is set to 1 for $s \in S$. The overall likelihood of the tree is equal to the following:

$$P(D|\mathbf{R}, T) = \sum_{s \in S} \pi(s) \mathcal{L}(\text{root} = s)$$

Above, $\pi(s)$ denotes the prior probability of state s , which we take to be the stationary probability of s under the continuous-time Markov process, following a number of works from the biological literature (Huelsenbeck et al. 2003; Nielsen 2002; Felsenstein 2004); see Appendix E.

We use the No U-Turn Sampler of RStan (Carpenter et al. 2017) to infer the posterior distributions over transition rates between different states for each categorical feature in our data set. Inference is run over 4 chains for 2000 iterations, with the first half of samples discarded as burn-in. This process is carried out for each tree in the tree sample, and posterior samples are combined for each feature.

C Ancestral State Reconstruction

For each categorical feature, we estimate the distribution over possible states or values at the root of the tree (i.e. for Proto-Indo-European) using samples from the posterior distribution of \mathbf{R} . For a sampled vector of rates $\hat{\mathbf{R}}$, the probability of state s at the root is equal to the following:

$$P(\text{root} = s | \hat{\mathbf{R}}) = \frac{\pi(s) \mathcal{L}(\text{root} = s)}{\sum_{r \in S} \pi(r) \mathcal{L}(\text{root} = r)}$$

At each iteration of the inference algorithm, we sample a state at the root as follows:

$$z(\text{root}) \sim \text{Categorical}(P(\text{root} | \hat{\mathbf{R}}))$$

We discard the first half of samples and average the remaining draws of z , yielding a probability between 0 and 1 for each state at the root of the tree.

D Validation

We employ a validation technique inspired by Leave-One-Out cross-validation (LOO-CV; see Vehtari et al. 2017 for a review) in order to see how well the phylogenetic model can reconstruct values observed at tips of the tree when they are held out during the inference process (in general, LOO-CV is used to facilitate direct comparison of goodness-of-fit between competing statistical models; the values we report here serve as a baseline measure against which to compare future work). In particular, we are interested in seeing how accurately state values for observed languages in our sample that are treated as ancestral to other languages (e.g. Latin, Sanskrit, Ancient Greek) relative to non-ancestral languages (e.g. Spanish, Hindi, Modern Greek); high accuracy for held-out ancestral languages indicates that our model carries out ancestral state reconstruction with high accuracy for attested ancestral languages (implying that the model has the potential to generalize to unattested

ancestral languages such as Proto-Indo-European). For each feature and each language in our data set, we sample a tree at random, set the likelihood of each state in the language under consideration to 1 (as recommended for missing data; Felsenstein 2004:255), then carry out the evolutionary rate inference described above. Subsequently, we use rates from the posterior distribution of \mathbf{R} to reconstruct the state of the held-out language t as follows. First, we sample a vector of rates $\hat{\mathbf{R}}$ from the posterior and use it to sample a state for the direct ancestor of t , which we denote as n :

$$z(n) \sim \text{Categorical}(\mathcal{L}(n|\hat{\mathbf{R}}))$$

We can use this sampled ancestral state to estimate the probability that t is in state r under a CTM process parameterized by $\hat{\mathbf{R}}$ and sample from this probability distribution:

$$\begin{aligned} P(t = r) &= P_{sr}(b(n, t); \mathbf{R}); \\ z &\sim \text{Categorical}(P(t = r)) \end{aligned}$$

We carry out this estimation procedure on a randomly sampled tree from our tree sample for each feature and language, and compute the percentage of held-out values generated on the basis of the posterior sample that match the attested value. Figure 1 shows these accuracy scores for each language-feature pair, divided according to whether the language is ancestral or non-ancestral. The overall median accuracy score, pooled across ancestral and non-ancestral languages, is 0.873. Accuracy scores are significantly higher for ancestral languages (median=0.977) than for non-ancestral languages (median=0.830) according to a Mann-Whitney U test ($W = 7147700, p < 2.2e^{-16}$), indicating that the use of ancestry constraints increases posterior predictive accuracy, and that our model can re-capture held-out ancestral values with considerable success. Additionally, we fit a mixed-effects model with log accuracy as a response to whether or not a language is ancestral, with random intercepts by linguistic variable and language,¹ finding via the likelihood ratio test that whether not a language is ancestral is a highly significant predictor of log accuracy ($\chi^2_{\text{LR}}(1) = 18.685, p < 0.0001$).

Additionally, we investigate the degree to which held-out accuracy is dependent on artifacts of the data. For non-ancestral languages, we assess the correlation between the probability of with which our model accurately generates a held-out value and the probability with which this value occurs among non-held-out languages. For ancestral languages, we measure the correlation between the probability of an accurate held-out value and the probability with which this value occurs among the held-out ancestral node's descendants. We find that both correlations are significant (non-ancestral: Spearman's $\rho = 0.221, p < 0.001$, ancestral: $\rho = 0.676, p < 0.001$), indicating that LOO-CV accuracy is sensitive to patterns found in the data. At the same time, these correlations are weak to moderate, indicating that other factors — possibly including the ability of our model to learn meaningful diachronic patterns — influence held-out accuracy as well.

¹The function call in `lme4` (Bates et al. 2015) is the following: `log(accuracy) ~ ancestral + (1|variable) + (1|language)`

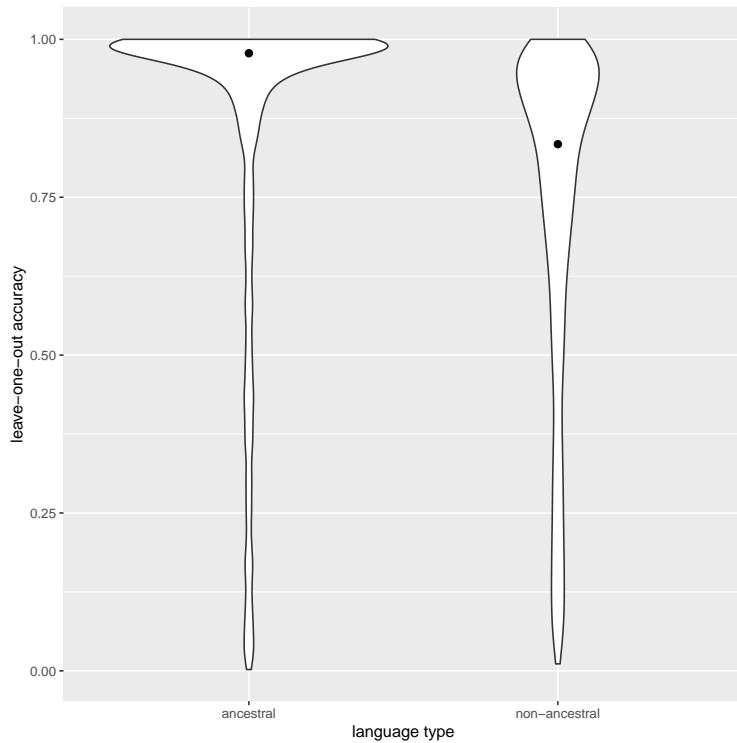


Figure 1: Held-out accuracy values for each language and feature, organized according to whether the feature is ancestral or not. Median values are indicated by dots.

E Choice of prior probability at root

We investigate the extent to which our reconstructions are sensitive to choices of ROOT PRIOR, a key ingredient in the PRUNING ALGORITHM (Felsenstein 1981, 2004). A standard practice in phylogenetics is to set the root prior to be equal to the stationary distribution of the variable of interest under the rates of the CTM process thought to characterize its evolution. For a binary character with a gain rate α and loss rate β , the stationary probability is equal to $\frac{\alpha}{\alpha+\beta}$.² For non-binary data, the stationary distribution π is a vector of probabilities satisfying the equations πQ and $\sum_{i=1}^{|\pi|} \pi_i = 1$, where Q is the CTM rate matrix. This practice presupposes that the character in question has been evolving for a ‘very long time according the particular model of [character evolution] we are using’ (Felsenstein 2004:255; cf. Cathcart 2018).

Though a sensible and established choice, this prior has the potential to influence the results of a phylogenetic reconstruction, particularly if the stationary probability is highly skewed toward a particular character value. To explore this issue, we carry out rate inference and reconstruction for the features in our data set using two alternative root priors, a UNIFORM prior which places equal prior probability of each value, and a DIRICHLET prior which infers the distribution of values at the root as a free parameter to be inferred. For a variable with D values, we set the prior probability of each value to $\frac{1}{D}$ under the uniform regime; under the Dirichlet regime, we place a D -length symmetric Dirichlet prior with a concentration parameter of 1 over the feature distribution at the root.

The different prior regimes reconstruct the same features with highest probability for the majority of variables, but differ according to a fraction of variables. These are presented below, along with the probabilities with which they are reconstructed, for stationary probability (SP), uniform prior (UP) and Dirichlet prior (DP); cells for which an alternative regime agrees with the SP regime are blank.

²An alternative parameterization for binary data is to draw a stationary probability $p \in [0, 1]$ and a change rate s , from which gain and loss rates can be derived as ps and $(1 - p)s$, respectively.

SP	UP	DP
Clitic finite V: Category irrelevant (0.442)	Clitic finite V: V2 (0.270)	Clitic finite V: V2 (0.269)
Clitic Infinitive V: Category irrelevant (0.433)	Clitic Infinitive V: V2 (0.254)	Clitic Infinitive V: V2 (0.249)
Clitic Participle V: Category irrelevant (0.418)	Clitic Participle V: V2 (0.236)	Clitic Participle V: V2 (0.240)
No case on article (0.732)	Case on article (0.621)	Case on article (0.618)
No difference O and Dative (pronouns) (0.570)	Difference, O and Dative (pronouns) (0.519)	Difference, O and Dative (pronouns) (0.529)
No Future by participle (0.724)	Future by participle (0.767)	Future by participle (0.762)
Not more than 7 cases (0.583)	More than 7 cases (0.948)	More than 7 cases (0.950)
NRel: Noun - Relative (0.627)	NRel: Relative - Noun (0.315)	NRel: Relative - Noun (0.316)
Possessor - Noun (0.585)	Possessor - Noun and Noun - Possessor (0.374)	Possessor - Noun and Noun - Possessor (0.377)
Reflexive with Agent (0.959)	Reflexive not with Agent (0.505)	Reflexive not with Agent (0.505)
Simple past: Full A Agreement (0.386)	—	Simple past: Syncretic A Agreement (0.206)

It is worth noting that with a handful of exceptions, the features reconstructed differently by the alternative models are reconstructed with high uncertainty, and as a whole, the differing features are not of key importance to the canonical model of reconstruction supported by the main results presented in this paper (see §3, RESULTS: RECONSTRUCTION).

F Entry/Gain and Exit/Loss Rates

For each multistate character, we compute the mean rate at which each state is gained or lost in the following manner. We compute the gain rate for state i , or rate at which state i is entered, as follows, where $R(j \rightarrow i)$ denotes the rate from state j to state i , and $p(s)$ denotes the equilibrium or stationary probability of state s :

$$\frac{\sum_{j \neq i} p(j) R(j \rightarrow i)}{\sum_{j \neq i} p(j)}$$

The loss rate for state i , or rate at which state i is exited, is computed as follows:

$$\sum_{j \neq i} R(i \rightarrow j)$$

We thank Gerhard Jäger for deriving the equation for entry rates for us, and for providing the following proof, which we reproduce with his permission:

Proof. Let us first consider the simpler case where we have a stochastic transition matrix P . We are interested in the probability of switching from state a or b to state c or d :

$$P(\{c, d\} | \{a, b\})$$

According to the definition of conditional probability, this is:

$$\frac{P(\{a, b\} \rightarrow \{c, d\})}{P(\{a, b\})}$$

This is only defined if we know $P(\{a, b\})$, so we assume that the process is in equilibrium and that these are the equilibrium probabilities. Since a and b are disjoint, we have $P(\{a, b\}) = P_E(a) + P_E(b)$ (P_E being the equilibrium probability.)

There are four different possible transitions in the numerator, which are mutually disjoint, so we have

$$\frac{P(a \rightarrow b) + P(a \rightarrow d) + P(b \rightarrow c) + P(b \rightarrow d)}{P_E(a) + P_E(b)}$$

Again, $P(a \rightarrow c)$ is only defined if we know the probability of the process starting in a . Under the equilibrium assumption, we have $P(a \rightarrow c) = P_E(a)P(c|a)$, and likewise for the other transitions.

Putting this together, we have

$$\begin{aligned} P(\{c, d\} | \{a, b\}) &= \frac{P_E(a)P(c|a) + P_E(a)P(d|a) + P_E(b)P(c|b) + P_E(b)P(d|b)}{P_E(a) + P_E(b)} \\ &= \frac{P_E(a)(P(c|a) + P(d|a)) + P_E(b)(P(c|b) + P(d|b))}{P_E(a) + P_E(b)} \end{aligned}$$

Now let us assume that we have a continuous-time Markov process, where P is time dependent. The rate $r_{\{a,b\} \rightarrow \{c,d\}}$ is the limit of the expected number of transitions from $\{a, b\}$ into $\{c, d\}$ per time period for infinitesimal time periods, provided the system starts in $\{a, b\}$:

$$\begin{aligned} r_{\{a,b\} \rightarrow \{c,d\}} &= \frac{d}{dt} P_t(\{c, d\} | \{a, b\}) \Big|_{t=0} \\ &= \frac{d}{dt} \frac{P_E(a)(P(c|a) + P(d|a)) + P_E(b)(P(c|b) + P(d|b))}{P_E(a) + P_E(b)} \Big|_{t=0} \end{aligned}$$

P_E does not depend on t , and $\frac{d}{dt} P_t(c|a) \Big|_{t=0} = r_{ac}$ (and likewise for other transitions); therefore we get

$$r_{\{a,b\} \rightarrow \{c,d\}} = \frac{P_E(a)(r_{ac} + r_{ad}) + P_E(b)(r_{bc} + r_{bd})}{P_E(a) + P_E(b)}$$

□

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Supplementary materials: data and results

S1

Languages, including latitude and longitude, used in the current study.

Language	Longitude	Latitude
Albanian (Tosk)	19.988251	40.446947
Angloromani	-2.355272	53.779521
Ashkun	70.791057	35.255909
Assamese	91.79022	26.143538
Avestan	55.9499	31.70708
Baluchi	65.03622	26.27794
Bengali	88.36119	22.566866
Breton	-4.102864	47.995619
Bulgarian	23.3535	42.698586
Catalan	2.179642	41.379225
Classical Greek	23.999205	37.696861
Cornish	-5.567517	50.191816
Croatian	15.992661	45.813486
Czech	14.468136	50.071244
Danish	12.583182	55.679885
Dutch	4.898126	52.374367
Elfdalian	14.040485	61.225938
English	-0.100059	51.497728
Faroese	-6.773322	62.009754
French	2.347857	48.854451
Frisian	5.795597	53.20394
Friulian	13.485001	46.127028
German	13.409092	52.520822
Gilaki	49.283999	37.526056
Gothic	20.199324	53.042874
Gujarati	72.139869	22.44456
Hindi	77.224996	28.625252
Hittite	34.621158	40.013951
Icelandic	-21.939672	64.144237
Irish	-9.301101	53.244432
Italian	12.385145	43.115956
Kashmiri	75.939182	34.322996
Kati	71.314571	35.799992
Khowar	72.51658	36.457958
Konkani	72.871066	19.262081
Kurdish (Kurmanji)	43.822746	37.788081

Kurdish (Sorani)	45.728512	35.821161
Ladin	11.923755	46.657384
Latin	12.4923	41.890189
Latvian	24.113274	56.915
Lithuanian	25.255852	54.680183
Low German	9.488653	53.931994
Luwian	36.788273	36.620598
Maithili	86.155454	26.075397
Maldivian	73.511939	4.17191
Manx	-4.484657	54.151988
Marathi	75.494714	19.38701
Middle Breton	-1.532472	47.207854
Middle Dutch	5.959192	52.213073
Middle English	-0.758622	51.313607
Middle Greek	28.997555	41.058644
Middle High German	9.717403	48.742717
Middle Irish	-8.634407	52.658918
Middle Low German	10.68504	53.867783
Middle Persian	51.675883	32.647027
Middle Welsh	-3.380017	52.240359
Modern Armenian	44.527159	40.147389
Modern Greek	23.694334	38.028622
Nepali	89.243625	26.659702
Norwegian (Bokmål)	10.740802	59.912785
Norwegian (Nynorsk)	5.075361	60.330984
Old Church Slavonic	30.453243	50.415519
Old Dutch	5.123259	52.09095
Old English	-1.314163	51.060696
Old French	2.347857	48.854451
Old Frisian	6.567738	53.215696
Old High German	9.962616	49.795477
Old Irish	-6.873827	53.726794
Old Italian	11.249249	43.776281
Old Norse	10.397522	63.426975
Old Persian	52.891196	29.935501
Old Portuguese	-8.629141	41.15818
Old Provençal	6.222519	43.426825
Old Prussian	19.900799	54.436292
Old Russian	31.275345	58.521428
Old Saxon	8.806043	53.07585
Old Spanish	-4.023666	39.857094
Old Swedish	16.321936	58.481083

Oriya	86.278412	20.608549
Ossetian (Iron)	44.675689	43.043802
Pali	83.000379	27.617895
Parachi	69.702595	34.832889
Pashto	68.188804	31.432929
Persian	55.748043	32.735314
Polish	20.994015	52.237892
Portuguese	-9.135132	38.708043
Prakrit	84.727979	25.379098
Prasun	70.741619	35.33661
Provençal	6.222519	43.426825
Punjabi	74.349411	31.536604
Romani (Arli)	19.881168	42.970349
Romani (Bugurdži)	21.222651	42.118106
Romani (Burgenland)	16.377534	47.193164
Romani (Kale)	21.470967	60.972087
Romani (Kelderash)	22.495093	47.187683
Romani (Lovara)	23.090199	47.401544
Romani (Sepečides)	27.131666	38.392804
Romani (Sinte)	10.203424	51.4992
Romanian	26.086373	44.427511
Romansh	9.838341	46.496755
Russian	37.64843	55.677584
Sanskrit	76.28612	23.511415
Sardinian	9.32737	40.31746
Scandoromani	13.158622	59.481307
Scottish Gaelic	-7.368974	57.16276
Serbian	20.472164	44.801327
Shughni	71.503041	38.389635
Sicilian	13.368345	38.115141
Sindhi	69.674802	23.253479
Sinhalese	79.85635	6.935115
Slovene	14.50823	46.050593
Sogdian	66.962682	39.646576
Spanish	-3.703482	40.416881
Swedish	17.438718	59.73823
Swiss German	8.538354	47.36888
Tajik	70.342617	38.663458
Talysh	48.730017	38.854174
Tocharian A	86.154785	41.760336
Tocharian B	81.514435	41.645502=
Ukrainian	30.525414	50.449474

Upper Sorbian	14.425442	51.179914
Urdu	73.018423	33.681135
Wakhi	72.760057	37.219477
Walloon	4.865382	50.464478
Welsh	-4.38518	52.926407
Yiddish	24.031167	49.853028

S2a

List of typological features (from DiACL database <https://diacl.ht.lu.se>) used in the current study.

Grid = topmost organizational unit in database, corresponding to linguistic domain; Feature = second organizational unit in database; Feature description = Description of Feature in database; Variant = lowest organizational unit in database; Variant description = description of variant in database; ID = unique database ID of Variant.

Grid	Feature	Feature description	Variant	Variant description	ID
Word order	Adpositions	Do adpositions normally occur before or after the noun?	Prep	Does the language have a substantial set of prepositions? E.g. English in the house	213
Word order	Adpositions	Do adpositions normally occur before or after the noun?	Post	Does the language have a substantial set of postpositions?	214
Word order	Noun-adjective	Do adjectives normally occur before or after the noun?	NA	Do most adjectives occur after the noun?	215
Word order	Noun-adjective	Do adjectives normally occur before or after the noun?	AN	Do most adjectives occur before the noun?	216
Word order	Noun-relative clause	Do relative clauses normally occur before or after the noun?	NRel	Do most relative clauses occur after the noun?	217
Word order	Noun-relative clause	Do relative clauses normally occur before or after the noun?	RelN	Do most relative clauses occur before the noun?	218
Word order	Noun-possessor	Do possessors normally occur before or after the noun?	N-Poss	Do most possessors occur after the noun they possess? The possessor should be an animate noun, and neither a proper name nor a pronoun!	219
Word order	Noun-possessor	Do possessors normally occur before or after the noun?	Poss-N	Do most possessors occur before the noun they possess? The possessor should be an animate noun, and neither a proper name nor a pronoun!	220
Word order	WH-element	What is the position of the WH-question word?	WH-initial	Is the WH-question word always obligatorily the first element in a question (e.g., it does not trigger inversion)?	221

Word order	WH-element	What is the position of the WH-question word?	WH-V	Does the WH-question word always immediately precede the verb (i.e., stand directly before the verb, either initially or non-initially)?	222
Word order	Main clause	What is the canonical (neutral) word order in a main clause?	SVO	What is the canonical (neutral) word order in a main clause? NB: V2 languages like Swe and Ger do NOT count as SVO even though SVO is most frequent.	223
Word order	Main clause	What is the canonical (neutral) word order in a main clause?	V2	V2 implies that initial adverb triggers V-SUBJ word order (Swedish, German etc.).	224
Word order	Main clause	What is the canonical (neutral) word order in a main clause?	VSO	What is the canonical (neutral) word order in a main clause?	225
Word order	Main clause	What is the canonical (neutral) word order in a main clause?	SOV	What is the canonical (neutral) word order in a main clause?	226
Word order	Subordinate clause	What is the canonical (neutral) word order in a subordinate clause?	SVO	What is the canonical (neutral) word order in a subordinate clause? NB: V2 languages like Swe and Ger do NOT count as SVO even though SVO is most frequent.	227
Word order	Subordinate clause	What is the canonical (neutral) word order in a subordinate clause?	V2	V2 implies that initial adverb triggers V-SUBJ word order (Swedish, German etc.).	228
Word order	Subordinate clause	What is the canonical (neutral) word order in a subordinate clause?	VSO	What is the canonical (neutral) word order in a subordinate clause?	229
Word order	Subordinate clause	What is the canonical (neutral) word order in a subordinate clause?	SOV	What is the canonical (neutral) word order in a subordinate clause?	230

Word order	Infinitive	Does the object normally occur before or after an infinitive? E.g.: to make pancakes (VO) Pfannkuchen machen (OV)	VO	231
Word order	Infinitive	Does the object normally occur before or after an infinitive? E.g.: to make pancakes (VO) Pfannkuchen machen (OV)	OV	232
Word order	Participle	Does the object normally occur before or after a participle? E.g.: making pancakes (VO) Pfannkuchen machend (OV)	VO	233
Word order	Participle	Does the object normally occur before or after a participle? E.g.: making pancakes (VO) Pfannkuchen machend (OV)	OV	234
Word order	Clitic pronouns finite verb	Does the clitic object pronoun normally occur before or after a finite verb? E.g.: Je les fais. (OV) If a language does not have clitic object pro- nouns, it would be 0 in both OV and VO.	VO	235

Word order	Clitic pronouns finite verb	Does the clitic object pronoun normally occur before or after a finite verb? E.g.: Je les fais. (OV) If a language does not have clitic object pronouns, it would be 0 in both OV and VO.	OV	236
Word order	Clitic pronouns finite verb	Does the clitic object pronoun normally occur before or after a finite verb? E.g.: Je les fais. (OV) If a language does not have clitic object pronouns, it would be 0 in both OV and VO.	2nd position	Does the clitic pronoun always occur in 2nd position, not specifically before or after the verb? (Wackernagel position)
Word order	Clitic pronouns infinitive	Does the clitic object pronoun normally occur before or after an infinitive? E.g.: Je veux les faire. (OV) If a language does not have clitic object pronouns, it would be 0 in both OV and VO.	VO	238
Word order	Clitic pronouns infinitive	Does the clitic object pronoun normally occur before or after an infinitive? E.g.: Je veux les faire. (OV) If a language does not have clitic object pronouns, it would be 0 in both OV and VO.	OV	239

Word order	Clitic pronouns infinitive	Does the clitic object pronoun normally occur before or after an infinitive? E.g.: Je veux les faire. (OV) If a language does not have clitic object pronouns, it would be 0 in both OV and VO.	2nd position	Does the clitic pronoun always occur in 2nd position, not specifically before or after the verb?	240
Word order	Clitic pronouns partitive	Does the clitic object pronoun normally occur before or after a participle? E.g.: En les faisant... (OV) If a language does not have clitic object pronouns, it would be 0 in both OV and VO.	VO		241
Word order	Clitic pronouns partitive	Does the clitic object pronoun normally occur before or after a participle? E.g.: En les faisant... (OV) If a language does not have clitic object pronouns, it would be 0 in both OV and VO.	OV		242

Word order	Cla	tic nouns	pro-par-	Does the clitic object pronoun normally occur before or after a participle? E.g.: En les faisant... (OV) If a language does not have clitic object pronouns, it would be 0 in both OV and VO.	2nd position	Does the clitic pronoun always occur in 2nd position, not specifically before or after the verb?	243
Nominal morphology	Nominal case	Nominal case		What is the realization of case at nouns (nominal heads)?	O-case	Are there different noun forms for agent and object case? (English: 0 (no cases) Russian: 1 (different noun forms for accusative and nominative) Basque: 1 (different noun forms for ergative and absolute))	244
Nominal morphology	Nominal case	Nominal case		What is the realization of case at nouns (nominal heads)?	DAT	Is there a specific case form for the recipient, which is different from the case form of, e.g., the object? (E.g. The man gives a book (O) to the child (DAT))	245
Nominal morphology	Nominal case	Nominal case		What is the realization of case at nouns (nominal heads)?	GEN	Is there a special case form to express genitive, which is different from the agent/object case?	246
Nominal morphology	Nominal case	Nominal case		What is the realization of case at nouns (nominal heads)?	GEN/DAT	Is there a special noun form to express genitive, which is not the same as dative (recipient) case?	247
Nominal morphology	Nominal case	Nominal case		What is the realization of case at nouns (nominal heads)?	VOC	Is there a special noun form to express vocative which is not the same as agent or object case?	248
Nominal morphology	Nominal case	Nominal case		What is the realization of case at nouns (nominal heads)?	OBL-Cases	Are there any cases besides agent, object, genitive, dative, and vocative? (E.g., local cases)	249
Nominal morphology	Nominal case	Nominal case		What is the realization of case at nouns (nominal heads)?	>7 Cases	Are there more than 7 cases?	250
Nominal morphology	Nominal case	Nominal case		What is the realization of case at nouns (nominal heads)?	AGGL.CASE	Are there cases which are visibly agglutinative, i.e., built up by several distinct, segmentable affixes?	251

Nominal morphology	Nominal case	What is the realization of case at nouns (nominal heads)?	AGGL.CASE.NR	Are plural cases formed by combining an (infixed) plural affix and a case affix in an agglutinative manner?	252
Nominal morphology	Pronominal case	What is the realization of case at pronouns (pronominal heads)? Mainly 1st and 2nd person pronouns, ignoring 3rd person pronouns (which often come from demonstratives).	A ≠ O	In pronouns, is the marking different for the case of the agent and object?	253
Nominal morphology	Pronominal case	What is the realization of case at pronouns (pronominal heads)? Mainly 1st and 2nd person pronouns, ignoring 3rd person pronouns (which often come from demonstratives).	DAT ≠ O	In pronouns, is the marking different for the case of the recipient and the object?	254
Nominal morphology	Pronominal case	What is the realization of case at pronouns (pronominal heads)? Mainly 1st and 2nd person pronouns, ignoring 3rd person pronouns (which often come from demonstratives).	VOC	See Nominal case	255

Nominal morphology	Pronominal case	What is the realization of case at pronouns (pronominal heads)? Mainly 1st and 2nd person pronouns, ignoring 3rd person pronouns (which often come from demonstratives).	OBL-Cases	See Nominal case	256
Nominal morphology	Pronominal case	What is the realization of case at pronouns (pronominal heads)? Mainly 1st and 2nd person pronouns, ignoring 3rd person pronouns (which often come from demonstratives).	>7 Cases	See Nominal case	257
Nominal morphology	Pronominal case	What is the realization of case at pronouns (pronominal heads)? Mainly 1st and 2nd person pronouns, ignoring 3rd person pronouns (which often come from demonstratives).	AGGL.CASE	See Nominal case	258
Nominal morphology	Pronominal case	What is the realization of case at pronouns (pronominal heads)? Mainly 1st and 2nd person pronouns, ignoring 3rd person pronouns (which often come from demonstratives).	AGGL.CASE.N\$	See Nominal case	259

Nominal morphology	Case marking	On which elements of the NP is the case marking obligatory?	CASE-LAST	Is the case marking obligatory on the last element of the NP (i.e., it is only realized once in the NP, even if it consists of several elements)?	260
Nominal morphology	Case marking	On which elements of the NP is the case marking obligatory?	CASE-FIRST	Is the case marking obligatory on the first element of the NP (i.e., it is only realized once in the NP, even if it consists of several elements)?	261
Nominal morphology	Case marking	On which elements of the NP is the case marking obligatory?	CASE-N	Is the case marking obligatory realized on the noun?	262
Nominal morphology	Case marking	On which elements of the NP is the case marking obligatory?	CASE-ADJ	Is the case marking obligatory on the adjective?	263
Nominal morphology	Case marking	On which elements of the NP is the case marking obligatory?	CASE-ART	Is the case marking realized on the article?	264
Nominal morphology	Gender / noun class	How is gender / noun class realized in the language?	M/F	Is there an obligatory gender distinction between masculine and feminine realized on an agreeing article or adjective? Can be either on the adjective (Russian) or on both the article and the adjective (German), or even on a verb (as in some NE Caucasian languages).	265
Nominal morphology	Gender / noun class	How is gender / noun class realized in the language?	NEUTR	Is there a special neutral gender for nouns realized on an agreeing article, adjective or verb?	266
Nominal morphology	Gender / noun class	How is gender / noun class realized in the language?	ANIM	Is there a special noun class for non-human animates realized on an agreeing article, adjective or verb?	267
Nominal morphology	Gender / noun class	How is gender / noun class realized in the language?	<5 GEN-DER	Are there more than 5 noun classes (or genders)?	268
Nominal morphology	Definiteness marking	How is definiteness marking realized in the language?	DEF-ART	Is there a special word class of definite articles which occur in NPs without adjectives? (E.g.: German, English but not Swedish)	269

Nominal morphology	Definiteness marking	How is definiteness marking realized in the language?	N-DEF	Is there a suffix for definiteness on the noun? (E.g.: Swedish but not English!)	270
Nominal morphology	Definiteness marking	How is definiteness marking realized in the language?	ADJ-DEF	Is there a suffix for definiteness on the adjective? This includes cases when the ADJ has a different form in definite and indefinite NPs (Swe “det stora huset”, Ger “das grosse Haus”).	271
Nominal morphology	Definiteness marking	How is definiteness marking realized in the language?	DEF-LAST	Is the definiteness marking obligatory on the last element of the NP (so it is only realized once in the NP, even if it consists of several elements)? If there is no definiteness marking at all, it will be 0!	272
Nominal morphology	Definiteness marking	How is definiteness marking realized in the language?	DEF-FIRST	Is the definiteness marking obligatory on the first element of the NP (so it is only realized once in the NP, even if it consists of several elements)? If there is no definiteness marking at all, it will be 0!	273
Nominal morphology	Gender agreement	How is gender agreement realized in the language?	PRED-ADJ	Does a predicative adjective agree with the subject of the clause in gender?	274
Nominal morphology	Preposition agreement	How is preposition agreement realized in the language?	PREP-PRON-AGR	Can a preposition agree in person with its object?	275
Verbal morphology	Simple PAST, A	In simple past, how is verbal agreement realized with respect to the agent?	PST:A-AGR-FULL	In simple past: does the verb crossreference the agent in all persons /numbers?	276
Verbal morphology	Simple PAST, A	In simple past, how is verbal agreement realized with respect to the agent?	PST:NO-A-AGR	In simple past: does the verb not crossreference the agent on the verb at all (e.g., Swedish)?	277
Verbal morphology	Simple PAST, A	In simple past, how is verbal agreement realized with respect to the agent?	PST:A-Gender-AGR	In simple past, does the verb agree in gender with the subject of a transitive verb? (e.g., Russian, Polish).	278

Verbal morphology	Simple PAST, O	In simple past, how is verbal agreement realized with respect to the object?	PST:O-AGR-FULL	In simple past: does the verb crossreference the object in all persons /numbers?	279
Verbal morphology	Simple PAST, O	In simple past, how is verbal agreement realized with respect to the object?	PST:NO-O-AGR	In simple past: does the verb not crossreference the object on the verb at all (e.g., Swedish, English, Russian)?	280
Verbal morphology	Simple PAST, O	In simple past, how is verbal agreement realized with respect to the object?	PST:O-Gender-AGR	In simple past, does the verb agree in gender with the object?	281
Verbal morphology	Simple PAST, DAT	In simple past, how is verbal agreement realized with respect to the indirect object of ditransitive verbs?	PST:DAT-AGR-FULL	In simple past: does the verb crossreference the dative in all persons /numbers?	282
Verbal morphology	Simple PAST, DAT	In simple past, how is verbal agreement realized with respect to the indirect object of ditransitive verbs?	PST:NO-DAT-AGR	In simple past: does the verb not crossreference the dative on the verb at all (e.g., Swedish, English, Russian)	283
Verbal morphology	Simple PAST, DAT	In simple past, how is verbal agreement realized with respect to the indirect object of ditransitive verbs?	PST:DAT-Gender-AGR	In simple past, does the verb agree in gender with the indirect object of a ditransitive verb?	284
Verbal morphology	Present progressive, A	In present progressive: how is verbal agreement realized with respect to the agent?	PROG:A-AGR-FULL	In present progressive: does the verb crossreference the agent in all persons /numbers?	285
Verbal morphology	Present progressive, A	In present progressive: how is verbal agreement realized with respect to the agent?	PROG:NO-A-AGR	In present progressive: does the verb not crossreference the agent on the verb at all (e.g., Swedish)	286

Verbal morphology	Present progressive, A	In present progressive: how is verbal agreement realized with respect to the agent?	PROG:A-Gender-AGR	In present progressive, does the verb agree in gender with the subject of a transitive verb?	287
Verbal morphology	Present progressive, O	In present progressive, how is verbal agreement organized with respect to the object?	PROG:O-AGR-FULL	In present progressive: does the verb crossreference the object in all persons /numbers?	288
Verbal morphology	Present progressive, O	In present progressive, how is verbal agreement organized with respect to the object?	PROG:NO-O-AGR	In present progressive: does the verb not crossreference the object on the verb at all (e.g. Swedish, Russian)?	289
Verbal morphology	Present progressive, O	In present progressive, how is verbal agreement organized with respect to the object?	PROG:O-Gender-AGR	In present progressive, does the verb agree in gender with the object of a transitive verb?	290
Verbal morphology	Present progressive, DAT	In present progressive, how is verbal agreement organized with respect to the indirect object of ditransitive verbs?	PROG:DAT-AGR-FULL	In present progressive: does the verb crossreference the indirect object of a ditransitive verb in all persons /numbers?	291
Verbal morphology	Present progressive, DAT	In present progressive, how is verbal agreement organized with respect to the indirect object of ditransitive verbs?	PROG:NO-DAT-AGR	In present progressive: does the verb not crossreference the indirect object of ditransitive verbs at all (e.g. Swedish, English, Russian)?	292
Verbal morphology	Present progressive, DAT	In present progressive, how is verbal agreement organized with respect to the indirect object of ditransitive verbs?	PROG:DAT-Gender-AGR	In the present progressive, does the verb agree in gender with the indirect object of a ditransitive verb?	293

Verbal morphology	Allocutive agreement	Does the verb agree with the receiver (the person one is speaking to) without the speaker being an argument in the sentence (allocutive agreement, probably no for all languages but Basque!)	ALLOC	Does the verb agree with the receiver (the person one is speaking to) without the speaker being an argument in the sentence (allocutive agreement, probably no for all languages but Basque!)	294
Tense	Future	How is future realized in the language?	FUT.AUX	Is there a future formed by an auxiliary? (E.g., will in English?)	295
Tense	Future	How is future realized in the language?	PERF.FUT	Is there a future formed by using the perfective aspect? (0 if the language does not have verbal aspects! E.g., Russian, Georgian)	296
Tense	Future	How is future realized in the language?	FUT.Participle	Is there a future formed by a participle? (E.g., Armenian, Basque)	297
Tense	Future	How is future realized in the language?	FUT.Particle	Is there a future formed by a particle preceding a finite verb? (E.g., Albanian)	298
Tense	Future	How is future realized in the language?	FUT.Synth	Is there a synthetical future? (E.g., French, Spanish)	299
Tense	Continous present	How is present progressive realized in the language?	Present	Is there a synthetic present in progressive function?	300
Tense	Continous present	How is present progressive realized in the language?	Progressive present	Is there a progressive present form constructed by combining a present participle with a finite auxiliary verb?	301
Alignment	Noun: Simple Past	In simple past: how is the marking of subject and object of nouns realized?	N:PST:A=O?	In simple past: Is the noun form for A the same as for O? Ie: Does the noun look the same when it is subject of a transitive clause than when it is object of a transitive clause?	302

Alignment	Noun: Simple Past	In simple past: how is the marking of subject and object of nouns realized?	N:PST:A=Sa?	In simple past: Is the noun form for A the same as for Sa? Ie: Does the noun look the same when it is subject of a transitive clause as when it is subject of an agentive intransitive verb such as "work" or "dance"?	303
Alignment	Noun: Simple Past	In simple past: how is the marking of subject and object of nouns realized?	N:PST:O=So?	In simple past: Is the noun form for O the same as for So? Ie: Does the noun look the same when it is object of a transitive clause as when it is subject of an unaccusative verb such as "fall" or "die"?	304
Alignment	Noun: Simple Past	In simple past: how is the marking of subject and object of nouns realized?	N:PST:Sa=So?	In simple past: Does a noun bear the same case form when it is Sa (subject of e.g. work) or So (subject of e.g. fall or die)? Ie: There does not exist a split into stative and active intransitive verbs.	305
Alignment	Noun: Present Progressive	In present progressive: how is the marking of subject and object of nouns realized?	N:PROG:A=O?	In present progressive: Is the noun form for A the same as for O? I.e.: Does the noun look the same when it is subject of a transitive clause and when it is object of a transitive clause?	306
Alignment	Noun: Present Progressive	In present progressive: how is the marking of subject and object of nouns realized?	N:PROG:A=Sa?	In present progressive: Is the noun form for A the same as for Sa? I.e.: Does the noun look the same when it is subject of a transitive clause and when it is subject of an agentive intransitive verb such as "work" or "dance"?	307
Alignment	Noun: Present Progressive	In present progressive: how is the marking of subject and object of nouns realized?	N:PROG:O=So?	In present progressive: Is the noun form for O the same as for So? I.e.: Does the noun look the same when it is object of a transitive clause and when it is subject of an unaccusative verb such as "fall" or "die"?	308

Alignment	Noun: Present Progressive	In present progressive: how is the marking of subject and object of nouns realized?	N:PROG: Sa=So?	In present progressive: does a noun bear the same case form when it is Sa (subject of e.g., "work") or So (subject of e.g., "fall" or "die")? I.e.: The language does not have a split between stative and active intransitive verbs.	309
Alignment	Pronoun: Simple Past	In present progressive: how is the marking of subject and object of pronouns realized?	P:PST: A=O?	In simple past: Is the pronoun form for A the same as for O? I.e.: Does the pronoun look the same when it is subject of a transitive clause than when it is object of a transitive clause?	310
Alignment	Pronoun: Simple Past	In present progressive: how is the marking of subject and object of pronouns realized?	P:PST: A=Sa?	In simple past: Is the pronoun form for A the same as for Sa? I.e.: Does the pronoun look the same when it is subject of a transitive clause than when it is subject of an agentive intransitive verb such as "work" or "dance"?	311
Alignment	Pronoun: Simple Past	In present progressive: how is the marking of subject and object of pronouns realized?	P:PST: O=So?	In simple past: Is the pronoun form for O the same as for So? I.e.: Does the pronoun look the same when it is object of a transitive clause than when it is subject of an unaccusative verb such as "fall" or "die"?	312
Alignment	Pronoun: Simple Past	In present progressive: how is the marking of subject and object of pronouns realized?	P:PST: Sa=So?	In simple past: Does the pronoun bear the same case form when it is Sa (subject of e.g. work) or So (subject of e.g. fall or die)? I.e.: There does not exist a split into stative and active intransitive verbs.	313
Alignment	Pronoun: Present Progressive	In present progressive: how is the marking of subject and object of pronouns realized?	P:PROG: A=O?	In present progressive: Is the pronoun form for A the same as for O? I.e.: Does the pronoun look the same when it is subject of a transitive clause than when it is object of a transitive clause?	314

Alignment	Pronoun: Present Progressive	In present progressive: how is the marking of subject and object of pronouns realized?	P:PROG: A=Sa?	In present progressive: Is the pronoun form for A the same as for Sa? I.e.: Does the pronoun look the same when it is subject of a transitive clause as when it is subject of an agentive intransitive verb such as “work” or “dance”?	315
Alignment	Pronoun: Present Progressive	In present progressive: how is the marking of subject and object of pronouns realized?	P:PROG: O=So?	In present progressive: Is the pronoun form for O the same as for So? I.e.: Does the pronoun look the same when it is object of a transitive clause than when it is subject of an unaccusative verb such as “die” or “fall”?	316
Alignment	Pronoun: Present Progressive	In present progressive: how is the marking of subject and object of pronouns realized?	P:PROG: Sa=So?	In present progressive: Does a pronoun bear the same case form when it is Sa (subject of e.g. work) or So (subject of e.g. fall or die)? Ie: There does not exist a split into stative and active intransitive verbs.	317
Alignment	Verb: Simple Past	In simple past, how is alignment realized on the verb?	V:PST:A=O?	In simple past: Is the verb affix for A the same as for O? I.e.: Does the verb look the same when it refers to the subject of a transitive clause than when it refers to the object of a transitive clause? If there is no O-marking on the verb, but there is an S-marking, the answer would be no, they do not look the same. (e.g., German, Russian) If there is neither an O, nor an A marking, like in Swedish, the answer would be yes, they look the same!	318
Alignment	Verb: Simple Past	In simple past, how is alignment realized on the verb?	V:PST:A=Sa?	In simple past: Is the verb affix for A the same as for Sa? I.e.: Does the verb look the same when it refers to subject of a transitive clause than when it refers to subject of an agentive intransitive verb like “work” or “dance”?	319

Alignment	Verb: Simple Past	In simple past, how is alignment realized on the verb?	V:PST:O=So? In simple past: Is the verb affix for O the same as for So? I.e.: Does the verb look the same when it refers to the object of a transitive clause as when it refers to the subject of an unaccusative verb (such as “fall” or “die”)?	320
Alignment	Verb: Simple Past	In simple past, how is alignment realized on the verb?	V:PST:Sa=So? In simple past: Is the verb affix the same for Sa (subject of e.g. work) as or So (subject of e.g. fall or die)? I.e., does the verb agreement affix look the same regardless of whether the verb is “work” or “die” (as in German: “arbeitete-st”, “starb-st”). I.e.: There does not exist a split into unaccusative and agentive intransitive verbs.	321
Alignment	Verb: Present Progressive	In present progressive, how is alignment realized on the verb?	V:PROG: A=O? In present progressive: Is the verb affix for A the same as for O? Ie: Does the verb look the same when it refers to the subject of a transitive clause than when it refers to the object of a transitive clause? If there is no O-marking on the verb, but there is an S-marking, the answer would be no, they do not look the same. (e.g. German, Russian) If there is neither an O, nor an A marking like in Swedish, the answer would be yes, they look the same!	322
Alignment	Verb: Present Progressive	In present progressive, how is alignment realized on the verb?	V:PROG: A=Sa? In present progressive: Is the verb affix for A the same as for Sa? Ie: Does the verb look the same when it refers to subject of a transitive clause as when it refers to subject of an agentive intransitive verb such as “work”?	323

Alignment	Verb: Present Progressive	In present pro- gressive, how is alignment realized on the verb?	V:PROG: O=So?	In present progressive: Is the verb affix the same for O as for So? Ie: Does the verb look the same when it refers to the object of a transi- tive clause as when it refers to the subject of an unac- cusative verb (such as “fall” or “die”)?	324
Alignment	Verb: Present Progressive	In present pro- gressive, how is alignment realized on the verb?	V:PROG: Sa=So?	In present progressive: Is the verb affix the same for Sa (subject of e.g. “work”) as or So (subject of e.g. “fall” or “die”)? I.e. does the verb agreement affix look the same regardless of whether the verb is “work” or “die” (as in German: arbeite-t, stirbt-t). I.e.: There does not exist a split into un- accusative and agentive in- transitive verbs.	325
Alignment	Compare PROG- PAST	What is the marking relation between subject and object in present progres- sive and simple past?	PROG_So= PAST_So	Does the subject of e.g. die or fall bear the same case in both progressive present and simple past? (the answer for e.g., Megrelian would be no)	326
Alignment	Compare PROG- PAST	What is the marking relation between subject and object in present progres- sive and simple past?	PROG_A= PAST_O	Does the subject of a transi- tive verb in the present progressive bear the same case form as the object of a transitive verb in the simple past? (e.g. as in Georgian)	327
Alignment	Compare PROG- PAST	What is the marking relation between subject and object in present progres- sive and simple past?	PAST_A= PROG_O	Does the subject of a transi- tive verb in the simple past bear the same case form as the object of a verb in the present progressive? (e.g., Kurdish)	328
Alignment	Reflexive pronoun in transitive clause	What is the align- ment of reflexive pronouns?	REFL-ref-A	In a transitive clause, can O be a reflexive which refers back to A (as in English “herself”, Swedish “sig”)?	329

Alignment	Reflexive pronoun in transitive clause	What is the alignment of reflexive pronouns?	REFL-ref-O	In a transitive clause, can A be a reflexive which refers back to O (as appears to be the case in some Caucasian languages)?	330
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S2b

Matrix of coding of schools with sources of data. ID = Variant ID of database (S2a).

ID	Canonical	Brugmann-Delbrück	Isolating	Hirt	Active-stative	Gamkrelidze & Ivanov
213	1	1900:104-109	0	1937:135f.	0	1995:313
214	1	1900:104-109	1	1937:135f.	1	1995:313
215	0		1	1937:243	0	
216	1	1900:94-100	1	1937:243	1	
217	0		1	1937:234	0	
218	1	1900:405-406	1	1937:235	1	1995:307
219	0		1	1937:234	0	
220	1	1900:102-103	1		1	1995:304
221	1	1900:259-271	NA		NA	
222	0		NA		NA	
223	0		1	1937:227ff	0	
224	0		0	1937:263f.	0	
225	0		1	1937:227ff	0	
226	1	1900:80-83	1	1937:227ff	1	1995:313f
227	0		1	1937:227ff	0	
228	0		0	1937:263f	0	
229	0		1	1937:227ff	0	
230	1	1900:83-85	1	1937:227ff	1	1995:313f
231	0		1	1937:267	0	
232	1	1900:80-83	1	1937:267	1	1995:313f
233	0		1	1937	0	
234	1	1900:80-83	1		1	1995:313f
235	0		0	1937:228ff	0	
236	0		0	1937:228ff	1	1995:313f
237	1	1900:416-417. 1893:475	1	1937:228ff	0	
238	NA		NA		NA	
239	NA		NA		NA	
240	NA		NA		NA	
241	NA		NA		NA	
242	NA		NA		NA	
243	NA		NA		NA	
244	1	1893:189-190	0	1934:29ff	1	1995:244f.
245	1	1893:189-190	0	1934:29ff	0	1995:249
246	1	1893:185-187	0	1934:29ff	0	1995:245
247	1	1893:184-187	0	1934:29ff	1	1995:246
248	1	1893:188	0	1934:29ff	NA	
249	1	1893:180-191	0	1934:29ff	0	1995:245ff
250	0	1893:180-191	0	1934:29ff	0	1995:245
251	0		0	1934:29ff	1	1995:245
252	0		0	1934:29ff	1	1995:245
253	1	1911: 412-427	0	1937:237	1	1995:253f
254	1		0	1937:237	0	1995:253f
255	0		0	1937:237	NA	
256	1		0	1937:237	0	1995:253f
257	0		0	1937:237	0	1995:253f
258	0		0	1937:237	NA	
259	0		0	1937:237	NA	
260	0		0	1934:29ff	1	1995:242
261	0		0	1934:29ff	0	1995:242
262	1	1893:172-400	0	1934:29ff	1	1995:242
263	1	1893:172-400	0	1934:29ff	1	1995:242
264	0		0	1934:29ff	0	1995:242
265	1	1893:132-133	0	1934:27ff	0	1995:243
266	1	1893:132-133	1	1934:27ff	1	
267	1	1893:132-133	1	1934:27ff	1	1995:238
268	0		0	1934:27ff	0	
269	0		1	1937:236f.	0	

270	0		0	0
271	0		0	0
272	0		1	1937:236f.
273	0		0	0
274	1			1
275	0		NA	0
276	1	1916:670-671	0	1928:357ff
277	0		0	0
278	0		0	0
279	0		NA	0
280	1		NA	0
281	0		NA	0
282	0		NA	0
283	1		NA	1
284	0		NA	0
285	1	1916:595-596	0	1928:357ff
286	0		0	1928:357ff
287	0		0	1928:357ff
288	0		NA	1
289	1		NA	0
290	0		NA	0
291	0		NA	NA
292	1		NA	NA
293	0		NA	NA
294	0		NA	0
295	0	1897:242-255	0	1928:357ff
296	0		0	1928:357ff
297	0		0	1928:357ff
298	0		0	1928:357ff
299	0		0	1928:357ff
300	1	1916:668-669	0	1928:357ff
301	0		0	1928:357ff
302	0		1	0
303	1	1893:187-188	1	1
304	0		1	1995:267
305	1		1	1995:267f
306	0		1	0
307	1		1	1
308	0		1	1995:267f
309	1		1	0
310	0		NA	0
311	1		NA	1
312	0		NA	1
313	1		NA	0
314	0		NA	0
315	1		NA	1
316	0		NA	1
317	1		NA	0
318	0		1	1934:76ff.
319	1		1	1934:76ff.
320	0		1	1934:76ff.
321	1		1	1934:76ff.
322	0		1	1934:76ff.
323	1		1	1934:76ff.
324	0		1	1934:76ff.
325	1		1	1934:76ff.
326	1		1	1934:76ff.
327	0		0	0
328	0		0	0
329	1	1893:497-498	NA	NA
330	0		NA	NA

S3a

Categorical variables and values recoded from the original binary DiACL data set. The column LABEL provides each re-coded variable followed by the possible values that it can express, along with the corresponding combination of values of feature variants from the original DiACL dataset. The column ID gives a unique feature ID (A = alignment, NM = nominal morphology, T = tense, VM = verbal morphology, WO = word order).

Label	ID	(Variant 1)	(Variant 2)	(Variant 3)	(Variant 4)
Present-Past		ALIGNMENT; Compare PROG-PAST; PAST_A=PROG_O	ALIGNMENT; Compare PROG-PAST; PROG_A=PST_O	ALIGNMENT; Compare PROG-PAST; PROG_So=PST_So	
Present-Past: No marking difference	A1	0	0	0	
Present-Past: A marking in Present	A2	0	0	1	
Progressive and Past					
Present-Past: Active-ergative in Present Prog and Past	A3	0	1	1	
Present-Past: All systems	A4	1	1	1	
Alignment; Noun: Present Progressive		ALIGNMENT; Noun: Present Progressive; N:PROG: O=So?	ALIGNMENT; Noun: Present Progressive; N:PROG:A=O?	ALIGNMENT; Noun: Present Progressive; N:PROG:A=Sa?	ALIGNMENT; Noun: Present Progressive; N:PROG:Sa=So?
Noun, Present progressive: Tripartite	A5	0	0	0	1
Noun, Present progressive: Nominative- accusative	A6	0	0	1	1
Noun, Present progressive: No marking	A7	1	1	1	1
Alignment; Noun: Simple Past		ALIGNMENT; Noun: Simple Past; N:PST: O=So?	ALIGNMENT; Noun: Simple Past; N:PST:A=O?	ALIGNMENT; Noun: Simple Past; N:PST:A=Sa?	ALIGNMENT; Noun: Simple Past; N:PST:Sa=So?
Noun, Simple past: Tripartite	A8	0	0	0	1
Noun, Simple past: Nominative- accusative	A9	0	0	1	1
Noun, Simple past: Ergative	A10	1	0	0	1
Noun, Simple past: No marking	A11	1	1	1	1
Alignment; Pronoun: Present Progressive		ALIGNMENT; Pronoun: Present Progressive; P:PROG: O=So?	ALIGNMENT; Pronoun: Present Progressive; P:PROG:A=O?	ALIGNMENT; Pronoun: Present Progressive; P:PROG:A=Sa?	ALIGNMENT; Pronoun: Present Progressive; P:PROG:Sa=So?

Pronoun, Present progressive: Nominative- accusative	A13	0	0	1	1
Pronoun, Present progressive: No marking	A14	1	1	1	1
Alignment; Pronoun: Simple Past	A15	ALIGNMENT; Pronoun: Simple Past; P:PST: O=So?	ALIGNMENT; Pronoun: Simple Past; P:PST:A=O?	ALIGNMENT; Pronoun: Simple Past; P:PST:A=Sa?	ALIGNMENT; Pronoun: Simple Past; P:PST:Sa=So?
Pronoun, Simple past: Tripartite	A16	0	0	1	1
Pronoun, Simple past: Nominative- accusative	A18	1	0	0	1
Pronoun, Simple past: Ergative	A19	1	1	1	1
Simple past: No marking					
Alignment; Reflexive pronoun in transitive clause, A	A20	ALIGNMENT; Reflexive Pronoun in trans. Clause; REFL-ref-A			
Reflexive not with Agent	A21	0			
Reflexive with Agent					
Alignment; Reflexive pronoun in transitive clause, O	A22	ALIGNMENT; Reflexive Pronoun in trans. Clause; REFL-ref-O			
Reflexive not with Object	A23	0			
Reflexive with Object					
Alignment; Verb: Present Progressive	A24	ALIGNMENT; Verb: Present Progressive; V:PROG: O=So?	ALIGNMENT; Verb: Present Progressive; V:PROG:A=O?	ALIGNMENT; Verb: Present Progressive; V:PROG:A=Sa?	ALIGNMENT; Verb: Present Progressive; V:PROG:Sa=So?
Verb, Present progressive: Tripartite	A25	0	0	1	1
Verb, Present progressive: Nominative- Accusative	A26	1	1	1	1
Verb, Present progressive: No marking					
Alignment; Verb: Simple Past	A27	ALIGNMENT; Verb: Simple Past; V:PST: O=So?	ALIGNMENT; Verb: Simple Past; V:PST:A=O?	ALIGNMENT; Verb: Simple Past; V:PST:A=Sa?	ALIGNMENT; Verb: Simple Past; V:PST:Sa=So?
Verb, Simple past: Tripartite		0	0	0	1

Verb, Simple past: Nominative-accusative	A28	0	0	1	1
Verb, Simple past: Ergative	A29	1	0	0	1
Verb, Simple past: No marking	A30	1	1	1	1
Nominal morphology; Case on adjective No case on adjective	NM1	0			
Case on adjective	NM2	1			
Nominal morphology; Case on article No case on article	NM3	0			
Case on article	NM4	1			
Nominal morphology; Case on NP No rule of case on last/first member of NP	NM5	0	Nominal morphology; Case marking; CASE-FIRST	Nominal morphology; Case marking; CASE-LAST	
Case on last member of NP	NM6	0			
Nominal morphology; Case on noun No case on noun	NM7	0			
Case on noun	NM8	1			
Nominal morphology; Definite suffix on adjective No definite suffix on adjective Definite suffix on adjective	NM9	0	Nominal morphology; Definiteness marking; ADJ-DEF		
NM10	1				
Nominal morphology; Definiteness obligatory No obligatory definiteness	NM11	0	Nominal morphology; Definiteness marking; DEF-FIRST	Nominal morphology; Definiteness marking; DEF-LAST	
Obligatory definiteness on last member of NP	NM12	0			
Obligatory definiteness on first member of NP	NM13	1	0		

Nominal morphology;	Nominal morphology;
Definite article	Definiteness marking; DEF.ART
No definite article	NM14 0
Definite article	NM15 1
Nominal morphology;	Nominal morphology;
Definite suffix noun	Definiteness marking; N-DEF
No definite suffix on noun	NM16 0
Definite suffix on noun	NM17 1
Nominal morphology; 5 genders	Nominal morphology; Gender / Noun class; <5 GENDER
Fewer than five genders	NM18 0
More than five genders	NM19 1
Nominal morphology;	Nominal morphology;
Noun class for animates	Gender / Noun class; ANIM
No noun class for animates	NM20 0
Noun class for animates	NM21 1
Nominal morphology;	Nominal morphology;
Masculine/feminine	Gender / Noun class; M/F
No masculine/feminine distinction	NM22 0
Masculine/feminine distinction	NM23 1
Nominal morphology;	Nominal morphology;
Neuter	Gender / Noun class; NEUTR
No neuter gender	NM24 0
Neuter gender	NM25 1
Nominal morphology;	Nominal morphology;
Gender on predicative adjective	Gender agreement; PRED-ADJ
No gender on predicative adjective	NM26 0
Gender on predicative adjective	NM27 1
Nominal morphology;	Nominal morphology;
More than 7 cases	Nominal cases; <7 Cases

Not more than 7 cases	NM28 0		
More than 7 cases	NM29 1		
Nominal morphology; Agglutination for number No agglutination for number Agglutination for number	Nominal morphology; Nominal cases; AGG.CASE.NR NM30 0		
Nominal morphology; Agglutination for case No agglutination for case Agglutination for case	Nominal morphology; Nominal cases; AGGL.CASE NM32 0		
Nominal morphology; Genitive/dative No genitive or dative Genitive but no dative Genitive but no dative Dative but no genitive Genitive and dative	Nominal morphology; Nominal cases; DAT NM34 0	Nominal morphology; Nominal cases; GEN 0	Nominal morphology; Nominal cases; GEN/DAT 0
Nominal morphology; Case difference A/O No case difference A and O Case difference A and O	Nominal morphology; Nominal cases; O-case NM39 0	1	0
Nominal morphology; Peripheral cases No peripheral cases Peripheral cases	Nominal morphology; Nominal cases; OBL-Cases NM41 0	1	1
Nominal morphology; Vocative No Vocative Vocative	Nominal morphology; Nominal cases; VOC NM43 0	0	0
Nominal morphology; Agreement on prepositions	Nominal morphology; Preposition agreement; PRON-AGR NM44 1	1	1

No agreement on prepositions	NM45 0
Agreement on prepositions	NM46 1
Nominal morphology; More tha 7 pronominal cases	Nominal morphology; Pronominal Cases; <7 Cases
Less than 7 pronominal cases (pronouns)	NM47 0
More than 7 pronominal cases (pronouns)	NM48 1
Nominal morphology; Agglutination for cases (pronouns)	Nominal morphology; Pronominal Cases; AGGL.CASE
No agglutination for number (pronouns)	NM49 0
Agglutination for number (pronouns)	NM50 1
Nominal morphology; Agglutination for case (pronouns)	Nominal morphology; Pronominal Cases; AGGL.CASE.NR
Agglutination for case (pronouns)	NM51 0
No agglutination for case (pronouns)	NM52 1
Nominal morphology; Difference A/O (pronouns)	Nominal morphology; Pronominal Cases; A \neq O
No difference A and O (pronouns)	NM53 0
Difference A and O (pronouns)	NM54 1
Nominal morphology; Difference O/DAT (pronouns)	Nominal morphology; Pronominal Cases; DAT \neq O
No difference O and Dative (pronouns)	NM55 0

Difference, O and Dative (pronouns)	NM56	1
Nominal morphology; Peripheral cases (pronouns)	Nominal morphology; Pronominal Cases; OBL-Cases	
No peripheral cases (pronouns)	NM57	0
Peripheral cases (pronouns)	NM58	1
Nominal morphology; Vocative (pronouns)	Nominal morphology; Pronominal Cases; VOC	
No Vocative (pronouns)	NM59	0
Vocative (pronouns)	NM60	1
Tense; Synthetic Present progressive No synthetic	TENSE; Continous present; Present ?	
Present progressive	T1	0
Synthetic Present progressive	T2	1
Tense; Present progressive by auxiliary	TENSE; Continous present; Progressive present	
No Present progressive by auxiliary	T3	0
Present progressive by auxiliary	T4	1
Tense; Future by auxiliary	TENSE; Future;	
No Future by auxiliary	FUT.AUX	
Future by auxiliary	T5	0
Tense; Future by participle	TENSE; Future;	
No Future by participle	FUT.Participle	
Future by participle	T7	0
Tense; Future by particle	TENSE; Future;	
No Future by particle	FUT.Particle	
Future by particle	T9	0
Tense; Synthetic future	TENSE; Future;	
No synthetic	FUT.Synth	
Future	T11	0

Synthetic Future	T12	1		
Tense; Future by perfect		TENSE; Future; PERF.FUT		
No Future by perfect	T13	0		
Future by perfect	T14	1		
Verbal morphology; Present progressive A Agreement		Verbal morphology; present progressive, A; PROG:A-AGR-FULL	Verbal morphology; present progressive, A; PROG:A-Gender-AGR	Verbal morphology; present progressive, A; PROG:NO-A-AGR
Present progressive: Syncretic A Agreement	VM1	0	0	0
Present progressive: No A Agreement	VM2	0	0	1
Present progressive: Gender A Agreement	VM3	0	1	0
Present progressive: Full A Agreement	VM4	1	0	0
Present progressive: Full and Gender A Agreement	VM5	1	1	0
Verbal morphology; Present progressive Dative Agreement		Verbal morphology; present progressive, DAT; PROG:DAT-AGR-FULL	Verbal morphology; present progressive, DAT; PROG:DAT-Gender-AGR	Verbal morphology; present progressive, DAT; PROG:NO-DAT-AGR
Present progressive: Syncretic Dative Agreement	VM6	0	0	0
Present progressive: No Dative Agreement	VM7	0	0	1
Present progressive: Full Dative Agreement	VM8	1	0	0
Verbal morphology; Present progressive O Agreement		Verbal morphology; present progressive, O; PROG:NO-O-AGR	Verbal morphology; present progressive, O; PROG:O-AGR-FULL	Verbal morphology; present progressive, O; PROG:O-Gender-AGR
Present progressive: Syncretic O Agreement	VM9	0	0	0
Present progressive: Full O Agreement	VM10	0	1	0

Present progressive: No O Agreement	VM11 1	0	0
Verbal morphology; Simple past A Agreement	Verbal morphology; simple PAST, A; PST:A-AGR-FULL	Verbal morphology; simple PAST, A; PST:A-Gender-AGR	Verbal morphology; simple PAST, A; PST:NO-A-AGR
Simple past: Syncretic A Agreement	VM12 0	0	0
Simple past: No A Agreement	VM13 0	0	1
Simple past: Gender A Agreement	VM14 0	1	0
Simple past: Full A Agreement	VM16 1	0	0
Simple past: Full and Gender A Agreement	VM17 1	1	0
Verbal morphology; Simple past Dative Agreement	Verbal morphology; simple PAST, DAT; PST:DAT-AGR-FULL	Verbal morphology; simple PAST, DAT; PST:DAT-Gender-AGR	Verbal morphology; simple PAST, DAT; PST:NO-DAT-AGR
Simple past: Syncretic Dative Agreement	VM18 0	0	0
Simple past: No Dative Agreement	VM19 0	0	1
Simple past: Gender Dative Agreement	VM20 0	1	0
Simple past: Full Dative Agreement	VM21 1	0	0
Verbal morphology; Simple past O Agreement	Verbal morphology; simple PAST, O; PST:NO-O-AGR	Verbal morphology; simple PAST, O; PST:O-AGR-FULL	Verbal morphology; simple PAST, O; PST:O-Gender-AGR
Simple past: Syncretic O Agreement	VM22 0	0	0
Simple past: Gender O Agreement	VM23 0	1	0
Simple past: Gender and full O Agreement	VM24 0	1	1
Simple past: No O Agreement	VM25 1	0	0
Word order; Postpositions No	Word order; Adpositions; Post WO1 0		
Postpositions Postpositions	WO2 1		
Word order; Prepositions	Word order; Adpositions; Prep		

No Prepositions	WO3 0			
Prepositions	WO4 1			
Word order; Clitic finite V Category irrelevant	Word order; Clitic pronouns finite verb; 2nd position	Word order; Clitic pronouns finite verb; OV	Word order; Clitic pronouns finite verb; VO	
Clitic finite V: WO5 0		0	0	
Clitic finite V: VO	WO6 0	0	1	
Clitic finite V: OV	WO7 0	1	0	
Clitic finite V: VO and OV	WO8 0	1	1	
Clitic finite V: V2	WO9 1	0	0	
Word order; Infinitive V Category irrelevant	Word order; Clitic pronouns infinitive; 2nd position	Word order; Clitic pronouns infinitive; OV	Word order; Clitic pronouns infinitive; VO	
Clitic Infinitive V: Category irrelevant	WO10 0	0	0	
Clitic Infinitive V: VO	WO11 0	0	1	
Clitic Infinitive V: OV	WO12 0	1	0	
Clitic Infinitive V: VO and OV	WO13 0	1	1	
Clitic Infinitive V: V2	WO14 1	0	0	
Word order; Clitic particle V Category irrelevant	Word order; Clitic pronouns participle; 2nd position	Word order; Clitic pronouns participle; OV	Word order; Clitic pronouns participle; VO	
Clitic Participle V: Category irrelevant	WO15 0	0	0	
Clitic Participle V: VO	WO16 0	0	1	
Clitic Participle V: OV	WO17 0	1	0	
Clitic Participle V: VO and OV	WO18 0	1	1	
Clitic Participle V: V2	WO19 1	0	0	
Word order; Infinitive Category irrelevant	Word order; Infinitive; OV	Word order; Infinitive; VO		
Infinitive: WO20 0		0		
Infinitive: VO	WO21 0	1		
Infinitive: OV	WO22 1	0		
Infinitive: OV and VO	WO23 1	1		
Word order; Main clause Main clause: VSO	Word order; Main clauses; SOV	Word order; Main clauses; SVO	Word order; Main clauses; V2	Word order; Main clauses; VSO
Main clause: WO24 0		0	0	1
Main clause: V2	WO25 0	0	1	0
Main clause: SVO	WO26 0	1	0	0
Main clause: SOV	WO27 1	0	0	0

Main clause: SOV/SVO	WO28 1	1	0	0
Word order; Posessor-Noun Possessor - Noun Noun - Possessor Possessor - Noun and Noun - Possessor	Word order; Noun-Possessor; N-Poss WO29 0	Word order; Noun-Possessor; Poss-N 1		
	WO30 1	0		
	WO31 1	1		
Word order; Noun-Adjective Noun - Adjective Adjective - Noun Adjective - Noun and Noun - Adjective	Word order; Noun-adjective; AN WO32 0	Word order; Noun-adjective; NA 1		
	WO33 1	0		
	WO34 1	1		
Word order; Nound - Relative NRel: Category irrelevant NRel: Relative - Noun NRel: Noun - Relative NRel: Relative - Noun and Noun - Relative	Word order; Noun-relative clause; NRel WO35 0	Word order; Noun-relative clause; RelN 0		
	WO36 0	1		
	WO37 1	0		
	WO38 1	1		
Word order; Participle Participle - O O - Participle Participle - O and O - Participle	Word order; Participle; OV WO39 0	Word order; Participle; VO 1		
	WO40 1	0		
	WO41 1	1		
Word order; Subordinate clause Subordinate clause: VSO Subordinate clause: V2 Subordinate clause: SVO Subordinate clause: SOV Subordinate clause: SOV and SVO	Word order; Subordinate clause; SOV WO42 0	Word order; Subordinate clause; SVO 0	Word order; Subordinate clause; V2 0	Word order; Subordinate clause; VSO 1
	WO43 0	0	1	0
	WO44 0	1	0	0
	WO45 1	0	0	0
	WO46 1	1	0	0
Word order; WH - Verb No WH - Verb (initial or not) WH - Verb (initial or not)	Word order; WH-element; WH-V WO47 0			
	WO48 1			

Word order; WH-initial	Word order; WH-element; WH-initial
No WH-initial (no inversion)	WO49 0
WH-initial (no inversion)	WO50 1

S3b

Coded variants of S2b (different schools) transformed into the traits of S3a, organized by their categorical features. ID = feature ID of S3a.

ID	Label	Canonical	Isolating	Active-stative
A1	Present-Past: No marking difference	0	0	0
A2	Present-Past: A marking in Present Progressive and Past	1	1	1
A3	Present-Past: Active-ergative in Present Prog and Past	0	0	0
A4	Present-Past: All systems	0	0	0
A5	Noun, Present progressive: Tripartite	0	0	0
A6	Noun, Present progressive: Nominative-accusative	1	0	0
A7	Noun, Present progressive: No marking	0	1	0
A8	Noun, Simple past: Tripartite	0	0	0
A9	Noun, Simple past: Nominative-accusative	1	0	0
A10	Noun, Simple past: Ergative	0	0	0
A11	Noun, Simple past: No marking	0	1	0
A13	Pronoun, Present progressive: Nominative-accusative	1	NA	0
A14	Pronoun, Present progressive: No marking	0	NA	0
A15	Pronoun, Simple past: Tripartite	0	NA	0
A16	Pronoun, Simple past: Nominative-accusative	1	NA	0
A18	Pronoun, Simple past: Ergative	0	NA	0
A19	Pronoun, Simple past: No marking	0	NA	0
A20	Reflexive not with Agent	0	NA	NA
A21	Reflexive with Agent	1	NA	NA
A22	Reflexive not with Object	1	NA	NA
A23	Reflexive with Object	0	NA	NA
A24	Verb, Present progressive: Tripartite	0	0	0
A25	Verb, Present progressive: Nominative-Accusative	1	0	0
A26	Verb, Present progressive: No marking	0	1	0
A27	Verb, Simple past: Tripartite	0	0	0
A28	Verb, Simple past: Nominative-accusative	1	0	0
A29	Verb, Simple past: Ergative	0	0	0
A30	Verb, Simple past: No marking	0	1	0
NM1	No case on adjective	0	1	0
NM2	Case on adjective	1	0	1
NM3	No case on article	1	1	1
NM4	Case on article	0	0	0
NM5	No rule of case on last/first member of NP	1	1	0
NM6	Case on last member of NP	0	0	1
NM7	No case on noun	0	1	0
NM8	Case on noun	1	0	1
NM9	No definite suffix on adjective	1	1	1
NM10	Definite suffix on adjective	0	0	0
NM11	No obligatory definiteness	1		1
NM12	Obligatory definiteness on last member of NP	0	1	0
NM13	Obligatory definiteness on first member of NP	0	0	0
NM14	No definite article	1	0	1
NM15	Definite article	0	1	0
NM16	No definite suffix on noun	1	1	1
NM17	Definite suffix on noun	0	0	0
NM18	Less than five genders	1	1	1
NM19	More than five genders	0	0	0
NM20	No noun class for animates	0	0	0
NM21	Noun class for animates	1	1	1
NM22	No masculine/feminine distinction	0	1	1
NM23	Masculine/feminine distinction	1	0	0
NM24	No neuter gender	0	0	0
NM25	Neuter gender	1	1	1
NM26	No gender on predicative adjective	0	NA	0
NM27	Gender on predicative adjective	1	NA	1
NM28	Not more than 7 cases	0	0	0
NM29	More than 7 cases	1	1	1

NM30	No agglutination for number	1	1	0
NM31	Agglutination for number	0	0	1
NM32	No agglutination for case	1	1	0
NM33	Agglutination for case	0	0	1
NM34	No genitive or dative	0	1	0
NM35	Genitive but no dative	0	0	0
NM36	Genitive but no genitive	0	0	0
NM37	Dative but no genitive	0	0	0
NM38	Genitive and dative	1	0	0
NM39	No case difference A and O	0	1	0
NM40	Case difference A and O	1	0	1
NM41	No peripheral cases	0	1	1
NM42	Peripheral cases	1	0	0
NM43	No Vocative	0	1	NA
NM44	Vocative	1	0	NA
NM45	No agreement on prepositions	1	NA	1
NM46	Agreement on prepositions	0	NA	0
NM47	Less than 7 pronominal cases (pronouns)	1	1	1
NM48	More than 7 pronominal cases (pronouns)	0	0	0
NM49	No agglutination for number (pronouns)	1	1	NA
NM50	Agglutination for number (pronouns)	0	0	NA
NM51	Agglutination for case (pronouns)	0	0	NA
NM52	No agglutination for case (pronouns)	1	1	NA
NM53	No difference A and O (pronouns)	0	1	0
NM54	Difference A and O (pronouns)	1	0	1
NM55	No difference O and Dative (pronouns)	0	1	1
NM56	Difference, O and Dative (pronouns)	1	0	0
NM57	No peripheral cases (pronouns)	0	1	1
NM58	Peripheral cases (pronouns)	1	0	0
NM59	No Vocative (pronouns)	1	1	NA
NM60	Vocative (pronouns)	0	0	NA
T1	No synthetic Present progressive	1	1	1
T2	Synthetic Present progressive	0	0	0
T3	No Present progressive by auxiliary	1	1	1
T4	Present progressive by auxiliary	0	0	0
T5	No Future by auxiliary	1	1	1
T6	Future by auxiliary	0	0	0
T7	No Future by participle	1	1	1
T8	Future by participle	0	0	0
T9	No Future by particle	1	1	1
T10	Future by particle	0	0	0
T11	No synthetic Future	1	1	1
T12	Synthetic Future	0	0	0
T13	No Future by perfect	1	1	1
T14	Future by perfect	0	0	0
VM1	Present progressive: Syncretic A Agreement	0	1	0
VM2	Present progressive: No A Agreement	0	0	0
VM3	Present progressive: Gender A Agreement	0	0	0
VM4	Present progressive: Full A Agreement	1	0	1
VM5	Present progressive: Full and Gender A Agreement	0	0	0
VM6	Present progressive: Syncretic Dative Agreement	0	NA	NA
VM7	Present progressive: No Dative Agreement	1	NA	NA
VM8	Present progressive: Full Dative Agreement	0	NA	NA
VM9	Present progressive: Syncretic O Agreement	0	NA	1
VM10	Present progressive: Full O Agreement	0	NA	0
VM11	Present progressive: No O Agreement	1	NA	0
VM12	Simple past: Syncretic A Agreement	0	1	1
VM13	Simple past: No A Agreement	0	0	0
VM14	Simple past: Gender A Agreement	0	0	0
VM16	Simple past: Full A Agreement	1	0	0
VM17	Simple past: Full and Gender A Agreement	0	0	0
VM18	Simple past: Syncretic Dative Agreement	0	NA	0
VM19	Simple past: No Dative Agreement	1	NA	1

VM20	Simple past: Gender Dative Agreement	0	NA	0
VM21	Simple past: Full Dative Agreement	0	NA	0
VM22	Simple past: Syncretic O Agreement	0	NA	1
VM23	Simple past: Gender O Agreement	0	NA	0
VM24	Simple past: Gender and full O Agreement	0	NA	0
VM25	Simple past: No O Agreement	1	NA	0
WO1	No Postpositions	0	0	0
WO2	Postpositions	1	1	1
WO3	No Prepositions	0	0	0
WO4	Prepositions	1	0	0
WO5	Claitic finite V: Category irrelevant	0	0	0
WO6	Claitic finite V: VO	0	0	0
WO7	Claitic finite V: OV	0	0	1
WO8	Claitic finite V: VO and OV	0	0	0
WO9	Claitic finite V: V2	0	0	0
WO10	Claitic Infinitive V: Category irrelevant	NA	NA	NA
WO11	Claitic Infinitive V: VO	NA	NA	NA
WO12	Claitic Infinitive V: OV	NA	NA	NA
WO13	Claitic Infinitive V: VO and OV	NA	NA	NA
WO14	Claitic Infinitive V: V2	NA	NA	NA
WO15	Claitic Participle V: Category irrelevant	NA	NA	NA
WO16	Claitic Participle V: VO	NA	NA	NA
WO17	Claitic Participle V: OV	NA	NA	NA
WO18	Claitic Participle V: VO and OV	NA	NA	NA
WO19	Claitic Participle V: V2	NA	NA	NA
WO20	Infinitive: Category irrelevant	0	0	0
WO21	Infinitive: VO	0	1	0
WO22	Infinitive: OV	1	1	1
WO23	Infinitive: OV and VO	0	1	0
WO24	Main clause: VSO	0	1	0
WO25	Main clause: V2	0	0	0
WO26	Main clause: SVO	0	1	0
WO27	Main clause: SOV	1	1	1
WO28	Main clause: SOV/SVO	0	1	0
WO29	Possessor - Noun	1	1	1
WO30	Noun - Possessor	0	1	0
WO31	Possessor ? Noun and Noun ? Possessor	0	1	0
WO32	Noun ? Adjective	0	1	0
WO33	Adjective - Noun	1	1	1
WO34	Adjective ? Noun and Noun ? Adjective	0	1	0
WO35	NRel: Category irrelevant	0	0	0
WO36	NRel: Relative - Noun	1	1	1
WO37	NRel: Noun - Relative	0	1	0
WO38	NRel: Relative - Noun and Noun - Relative	0	1	0
WO39	Participle - O	0	1	0
WO40	O - Participle	1	1	1
WO41	Participle - O and O - Participle	0	1	0
WO42	Subordinate clause: VSO	0	1	0
WO43	Subordinate clause: V2	0	0	0
WO44	Subordinate clause: SVO	0	1	0
WO45	Subordinate clause: SOV	1	1	1
WO46	Subordinate clause: SOV and SVO	0	1	0
WO47	No WH - Verb (initial or not)	1	NA	NA
WO48	WH - Verb (initial or not)	0	NA	NA
WO49	No WH-initial (no inversion)	0	NA	NA
WO50	WH-initial (no inversion)	1	NA	NA

S4

Reconstruction probabilities for values of each variable.

ID	Value	SP	Dir	Unif
A1	Present-Past: A marking in Present Progressive and Past	0.781	0.312	0.311
A2	Present-Past: Active-ergative in Present Progressive and Past	0.101	0.200	0.200
A3	Present-Past: All systems	0.091	0.251	0.251
A4	Present-Past: No marking difference	0.027	0.236	0.237
A5	Noun, Present progressive: No marking	0.315	0.315	0.312
A6	Noun, Present progressive: Nominative-accusative	0.654	0.363	0.361
A7	Noun, Present progressive: Tripartite	0.031	0.321	0.328
A8	Noun, Simple past: Ergative	0.125	0.189	0.187
A9	Noun, Simple past: No marking	0.303	0.272	0.274
A10	Noun, Simple past: Nominative-accusative	0.538	0.297	0.302
A11	Noun, Simple past: Tripartite	0.035	0.242	0.238
A12	Pronoun, Present progressive: No marking	0.092	0.463	0.461
A13	Pronoun, Present progressive: Nominative-accusative	0.908	0.537	0.539
A14	Pronoun, Simple past: Ergative	0.082	0.143	0.146
A15	Pronoun, Simple past: No marking	0.061	0.197	0.197
A16	Pronoun, Simple past: Nominative-accusative	0.831	0.446	0.447
A17	Pronoun, Simple past: Tripartite	0.027	0.214	0.211
A18	Reflexive not with Agent	0.041	0.505	0.505
A19	Reflexive with Agent	0.959	0.495	0.495
A20	Reflexive not with Object	0.958	0.547	0.548
A21	Reflexive with Object	0.042	0.453	0.452
A22	Verb, Present progressive: A=O/So=O	0.025	0.241	0.242
A23	Verb, Present progressive: No marking	0.060	0.244	0.244
A24	Verb, Present progressive: Nominative-Accusative	0.874	0.276	0.277
A25	Verb, Present progressive: Tripartite	0.041	0.239	0.237
A26	Verb, Simple past: Double oblique	0.031	0.192	0.194
A27	Verb, Simple past: Ergative	0.106	0.168	0.175
A28	Verb, Simple past: No marking	0.105	0.202	0.197
A29	Verb, Simple past: Nominative-accusative	0.675	0.251	0.252
A30	Verb, Simple past: Tripartite	0.084	0.186	0.182
NM1	Case on adjective	0.559	0.618	0.609
NM2	No case on adjective	0.441	0.382	0.391
NM3	Case on article	0.267	0.618	0.621
NM4	No case on article	0.733	0.382	0.379
NM5	Case on last member of NP	0.076	0.121	0.124
NM6	No rule of case on last/first member of NP	0.924	0.879	0.876
NM7	Case on noun	0.745	0.517	0.522
NM8	No case on noun	0.255	0.482	0.478

NM9	Definite suffix on adjective	0.076	0.301	0.303
NM10	No definite suffix on adjective	0.924	0.699	0.697
NM11	No obligatory definiteness	0.857	0.556	0.563
NM12	Obligatory definiteness on first member of NP	0.076	0.096	0.098
NM13	Obligatory definiteness on last member of NP	0.067	0.348	0.339
NM14	Definite article	0.059	0.087	0.085
NM15	No definite article	0.941	0.913	0.915
NM16	Definite suffix on noun	0.088	0.197	0.195
NM17	No definite suffix on noun	0.912	0.803	0.805
NM18	Fewer than five genders	0.987	0.582	0.588
NM19	More than five genders	0.013	0.418	0.412
NM20	No noun class for animates	0.913	0.591	0.588
NM21	Noun class for animates	0.087	0.409	0.412
NM22	Masculine/feminine distinction	0.684	0.597	0.598
NM23	No masculine/feminine distinction	0.316	0.403	0.402
NM24	Neuter gender	0.855	0.966	0.968
NM25	No neuter gender	0.145	0.034	0.032
NM26	Gender on predicative adjective	0.673	0.624	0.620
NM27	No gender on predicative adjective	0.327	0.376	0.380
NM28	More than 7 cases	0.416	0.950	0.949
NM29	Not more than 7 cases	0.584	0.050	0.051
NM30	Agglutination for number	0.229	0.361	0.356
NM31	No agglutination for number	0.771	0.639	0.644
NM32	Agglutination for case	0.218	0.429	0.426
NM33	No agglutination for case	0.782	0.571	0.574
NM34	Dative but no genitive	0.070	0.251	0.252
NM35	Genitive and dative	0.608	0.399	0.405
NM36	Genitive but no dative	0.138	0.235	0.234
NM37	No genitive or dative	0.184	0.116	0.110
NM38	Case difference A and O	0.715	0.561	0.561
NM39	No case difference A and O	0.285	0.439	0.439
NM40	No peripheral cases	0.017	0.003	0.003
NM41	Peripheral cases	0.983	0.997	0.997
NM42	No Vocative	0.115	0.054	0.053
NM43	Vocative	0.885	0.946	0.947
NM44	Agreement on prepositions	0.032	0.111	0.109
NM45	No agreement on prepositions	0.968	0.889	0.891
NM46	Fewer than 7 pronominal cases (pronouns)	0.969	0.544	0.546
NM47	More than 7 pronominal cases (pronouns)	0.031	0.456	0.454
NM48	Agglutination for number (pronouns)	0.081	0.190	0.185
NM49	No agglutination for number (pronouns)	0.919	0.810	0.815
NM50	Agglutination for case (pronouns)	0.962	0.760	0.759

NM51	No agglutination for case (pronouns)	0.038	0.240	0.241
NM52	Difference A and O (pronouns)	0.934	0.743	0.741
NM53	No difference A and O (pronouns)	0.066	0.257	0.259
NM54	Difference, O and Dative (pronouns)	0.429	0.529	0.519
NM55	No difference O and Dative (pronouns)	0.571	0.471	0.481
NM56	No peripheral cases (pronouns)	0.077	0.013	0.011
NM57	Peripheral cases (pronouns)	0.922	0.987	0.989
NM58	No Vocative (pronouns)	0.985	0.549	0.551
NM59	Vocative (pronouns)	0.015	0.451	0.449
T1	No synthetic Present progressive	0.078	0.382	0.379
T2	Synthetic Present progressive	0.922	0.618	0.621
T3	No Present progressive by auxiliary	0.676	0.562	0.559
T4	Present progressive by auxiliary	0.324	0.438	0.441
T5	Future by auxiliary	0.372	0.425	0.427
T6	No Future by auxiliary	0.628	0.575	0.573
T7	Future by participle	0.276	0.762	0.768
T8	No Future by participle	0.724	0.238	0.232
T9	Future by particle	0.107	0.368	0.368
T10	No Future by particle	0.893	0.632	0.632
T11	No synthetic Future	0.731	0.661	0.662
T12	Synthetic Future	0.270	0.339	0.338
T13	Future by perfect	0.020	0.272	0.279
T14	No Future by perfect	0.980	0.728	0.721
VM1	Present progressive: Full A Agreement	0.657	0.329	0.327
VM2	Present progressive: Full and Gender A Agreement	0.025	0.190	0.194
VM3	Present progressive: Gender A Agreement	0.041	0.190	0.190
VM4	Present progressive: No A Agreement	0.065	0.183	0.179
VM5	Present progressive: Syncretic A Agreement	0.212	0.107	0.110
VM6	Present progressive: Full Dative Agreement	0.020	0.304	0.308
VM7	Present progressive: No Dative Agreement	0.922	0.420	0.420
VM8	Present progressive: Syncretic Dative Agreement	0.057	0.277	0.272
VM9	Present progressive: Full O Agreement	0.022	0.302	0.308
VM10	Present progressive: No O Agreement	0.920	0.418	0.416
VM11	Present progressive: Syncretic O Agreement	0.058	0.280	0.276
VM12	Simple past: Full A Agreement	0.031	0.201	0.203
VM13	Simple past: Full and Gender A Agreement	0.270	0.198	0.200
VM14	Simple past: Gender A Agreement	0.049	0.200	0.200
VM15	Simple past: No A Agreement	0.056	0.195	0.199
VM16	Simple past: Syncretic A Agreement	0.207	0.207	0.199
VM17	Simple past: Full A Agreement	0.387	0.201	0.203
VM18	Simple past: Full Dative Agreement	0.022	0.240	0.237
VM19	Simple past: Gender Dative Agreement	0.021	0.237	0.238

VM20	Simple past: No Dative Agreement	0.893	0.302	0.303
VM21	Simple past: Syncretic Dative Agreement	0.064	0.222	0.222
VM22	Simple past: Gender and full O Agreement	0.028	0.189	0.183
VM23	Simple past: Gender O Agreement	0.036	0.185	0.183
VM24	Simple past: No O Agreement	0.785	0.289	0.296
VM25	Simple Past: Syncretic and gender A Agreement	0.067	0.172	0.171
VM26	Simple past: Syncretic O Agreement	0.083	0.165	0.168
WO1	No Postpositions	0.151	0.052	0.050
WO2	Postpositions	0.849	0.948	0.950
WO3	No Prepositions	0.738	0.819	0.817
WO4	Prepositions	0.262	0.181	0.183
WO5	Clitic finite V: Category irrelevant	0.442	0.171	0.168
WO6	Clitic finite V: OV	0.141	0.165	0.164
WO7	Clitic finite V: V2	0.161	0.269	0.270
WO8	Clitic finite V: VO	0.181	0.183	0.186
WO9	Clitic finite V: VO and OV	0.074	0.212	0.212
WO10	Clitic Infinitive V: Category irrelevant	0.434	0.137	0.136
WO11	Clitic Infinitive V: OV	0.189	0.208	0.206
WO12	Clitic Infinitive V: V2	0.162	0.249	0.254
WO13	Clitic Infinitive V: VO	0.169	0.205	0.210
WO14	Clitic Infinitive V: VO and OV	0.046	0.200	0.195
WO15	Clitic Participle V: Category irrelevant	0.418	0.140	0.149
WO16	Clitic Participle V: OV	0.198	0.201	0.196
WO17	Clitic Participle V: V2	0.148	0.241	0.237
WO18	Clitic Participle V: VO	0.181	0.208	0.214
WO19	Clitic Participle V: VO and OV	0.054	0.210	0.204
WO20	Infinitive: Category irrelevant	0.063	0.262	0.262
WO21	Infinitive: OV	0.806	0.405	0.404
WO22	Infinitive: OV and VO	0.039	0.246	0.248
WO23	Infinitive: VO	0.092	0.087	0.086
WO24	Main clause: SOV	0.905	0.640	0.638
WO25	Main clause: SOV/SVO	0.010	0.134	0.137
WO26	Main clause: SVO	0.034	0.028	0.029
WO27	Main clause: V2	0.030	0.058	0.056
WO28	Main clause: VSO	0.021	0.140	0.139
WO29	Noun - Possessor	0.347	0.338	0.337
WO30	Possessor - Noun	0.585	0.285	0.289
WO31	Possessor - Noun and Noun - Possessor	0.068	0.377	0.374
WO32	Adjective - Noun	0.870	0.536	0.538
WO33	Adjective - Noun and Noun - Adjective	0.054	0.306	0.306
WO34	Noun - Adjective	0.076	0.158	0.156
WO35	NRel: Category irrelevant	0.040	0.280	0.282

WO36	NRel: Noun - Relative	0.627	0.118	0.113
WO37	NRel: Relative - Noun	0.292	0.316	0.316
WO38	NRel: Relative - Noun and Noun - Relative	0.041	0.286	0.289
WO39	O - Participle	0.894	0.619	0.618
WO40	Participle - O	0.050	0.054	0.054
WO41	Participle - O and O - Participle	0.057	0.327	0.327
WO42	Subordinate clause: SOV	0.899	0.558	0.560
WO43	Subordinate clause: SOV and SVO	0.012	0.162	0.160
WO44	Subordinate clause: SVO	0.037	0.025	0.027
WO45	Subordinate clause: V2	0.014	0.092	0.089
WO46	Subordinate clause: VSO	0.038	0.163	0.163
WO47	No WH - Verb (initial or not)	0.778	0.801	0.800
WO48	WH - Verb (initial or not)	0.222	0.199	0.200
WO49	No WH-initial (no inversion)	0.212	0.178	0.176
WO50	WH-initial (no inversion)	0.788	0.822	0.824

S5

Transition rates for features, organized by category (S3a).

Feature 1	Feature 1	Rate(F1→F2)
Present-Past: A marking in Present Progressive and Past	Present-Past: Active-ergative in Present Progressive and Past	0.090
Present-Past: A marking in Present Progressive and Past	Present-Past: All systems	0.237
Present-Past: A marking in Present Progressive and Past	Present-Past: No marking difference	0.057
Present-Past: Active-ergative in Present Progressive and Past	Present-Past: A marking in Present Progressive and Past	0.563
Present-Past: Active-ergative in Present Progressive and Past	Present-Past: All systems	0.609
Present-Past: Active-ergative in Present Progressive and Past	Present-Past: No marking difference	0.330
Present-Past: All systems	Present-Past: A marking in Present Progressive and Past	1.663
Present-Past: All systems	Present-Past: Active-ergative in Present Progressive and Past	0.906
Present-Past: All systems	Present-Past: No marking difference	0.462
Present-Past: No marking difference	Present-Past: A marking in Present Progressive and Past	1.552
Present-Past: No marking difference	Present-Past: Active-ergative in Present Progressive and Past	1.569
Present-Past: No marking difference	Present-Past: All systems	1.526
Noun, Present progressive: No marking	Noun, Present progressive: Nominative-accusative	1.044
Noun, Present progressive: No marking	Noun, Present progressive: Tripartite	0.175
Noun, Present progressive: Nominative-accusative	Noun, Present progressive: No marking	0.593
Noun, Present progressive: Nominative-accusative	Noun, Present progressive: Tripartite	0.082
Noun, Present progressive: Tripartite	Noun, Present progressive: No marking	1.563
Noun, Present progressive: Tripartite	Noun, Present progressive: Nominative-accusative	1.819
Noun, Simple past: Ergative	Noun, Simple past: No marking	0.365
Noun, Simple past: Ergative	Noun, Simple past: Nominative-accusative	0.533
Noun, Simple past: Ergative	Noun, Simple past: Tripartite	0.310

Noun, Simple past: No marking	Noun, Simple past: Ergative	0.282
Noun, Simple past: No marking	Noun, Simple past: Nominative-accusative	1.105
Noun, Simple past: No marking	Noun, Simple past: Tripartite	0.194
Noun, Simple past: Nominative-accusative	Noun, Simple past: Ergative	0.113
Noun, Simple past: Nominative-accusative	Noun, Simple past: No marking	0.751
Noun, Simple past: Nominative-accusative	Noun, Simple past: Tripartite	0.095
Noun, Simple past: Tripartite	Noun, Simple past: Ergative	1.455
Noun, Simple past: Tripartite	Noun, Simple past: No marking	1.336
Noun, Simple past: Tripartite	Noun, Simple past: Nominative-accusative	1.629
Pronoun, Present progressive: No marking	Pronoun, Present progressive: Nominative-accusative	0.807
Pronoun, Present progressive: Nominative-accusative	Pronoun, Present progressive: No marking	0.118
Pronoun, Simple past: Ergative	Pronoun, Simple past: No marking	0.301
Pronoun, Simple past: Ergative	Pronoun, Simple past: Nominative-accusative	0.326
Pronoun, Simple past: Ergative	Pronoun, Simple past: Tripartite	0.311
Pronoun, Simple past: No marking	Pronoun, Simple past: Ergative	0.828
Pronoun, Simple past: No marking	Pronoun, Simple past: Nominative-accusative	0.641
Pronoun, Simple past: No marking	Pronoun, Simple past: Tripartite	0.502
Pronoun, Simple past: Nominative-accusative	Pronoun, Simple past: Ergative	0.061
Pronoun, Simple past: Nominative-accusative	Pronoun, Simple past: No marking	0.140
Pronoun, Simple past: Nominative-accusative	Pronoun, Simple past: Tripartite	0.057
Pronoun, Simple past: Tripartite	Pronoun, Simple past: Ergative	1.547
Pronoun, Simple past: Tripartite	Pronoun, Simple past: No marking	1.156
Pronoun, Simple past: Tripartite	Pronoun, Simple past: Nominative-accusative	1.261
Reflexive not with Agent	Reflexive with Agent	0.888
Reflexive with Agent	Reflexive not with Agent	0.042
Reflexive not with Object	Reflexive with Object	0.035
Reflexive with Object	Reflexive not with Object	0.548
Verb, Present progressive: A=O/So=O	Verb, Present progressive: No marking	1.299

Verb, Present progressive: A=O/So=O	Verb, Present progressive: Nominative-Accusative	progressive: 1.546
Verb, Present progressive: A=O/So=O	Verb, Present progressive: Tripartite	1.192
Verb, Present progressive: No marking	Verb, Present progressive: A=O/So=O	0.587
Verb, Present progressive: No marking	Verb, Present progressive: Nominative-Accusative	1.552
Verb, Present progressive: No marking	Verb, Present progressive: Tripartite	0.734
Verb, Present progressive: Nominative-Accusative	Verb, Present progressive: A=O/So=O	0.037
Verb, Present progressive: Nominative-Accusative	Verb, Present progressive: No marking	0.129
Verb, Present progressive: Nominative-Accusative	Verb, Present progressive: Tripartite	0.044
Verb, Present progressive: Tripartite	Verb, Present progressive: A=O/So=O	0.734
Verb, Present progressive: Tripartite	Verb, Present progressive: No marking	0.963
Verb, Present progressive: Tripartite	Verb, Present progressive: Nominative-Accusative	1.214
Verb, Simple past: Double oblique	Verb, Simple past: Ergative	1.480
Verb, Simple past: Double oblique	Verb, Simple past: No marking	1.291
Verb, Simple past: Double oblique	Verb, Simple past: Nominative-accusative	1.431
Verb, Simple past: Double oblique	Verb, Simple past: Tripartite	1.443
Verb, Simple past: Ergative	Verb, Simple past: Double oblique	0.374
Verb, Simple past: Ergative	Verb, Simple past: No marking	0.463
Verb, Simple past: Ergative	Verb, Simple past: Nominative-accusative	0.536
Verb, Simple past: Ergative	Verb, Simple past: Tripartite	0.705
Verb, Simple past: No marking	Verb, Simple past: Double oblique	0.437
Verb, Simple past: No marking	Verb, Simple past: Ergative	0.753
Verb, Simple past: No marking	Verb, Simple past: Nominative-accusative	1.485
Verb, Simple past: No marking	Verb, Simple past: Tripartite	0.775
Verb, Simple past: Nominative-accusative	Verb, Simple past: Double oblique	0.053
Verb, Simple past: Nominative-accusative	Verb, Simple past: Ergative	0.064
Verb, Simple past: Nominative-accusative	Verb, Simple past: No marking	0.371

Verb, Simple past: Nominative-accusative	Verb, Simple past: Tripartite	0.073
Verb, Simple past: Tripartite	Verb, Simple past: Double oblique	0.508
Verb, Simple past: Tripartite	Verb, Simple past: Ergative	1.002
Verb, Simple past: Tripartite	Verb, Simple past: No marking	0.676
Verb, Simple past: Tripartite	Verb, Simple past: Nominative-accusative	0.811
Case on adjective	No case on adjective	0.562
No case on adjective	Case on adjective	0.408
Case on article	No case on article	0.722
No case on article	Case on article	0.182
Case on last member of NP	No rule of case on last/first member of NP	0.258
No rule of case on last/first member of NP	Case on last member of NP	0.138
Case on noun	No case on noun	0.316
No case on noun	Case on noun	0.718
Definite suffix on adjective	No definite suffix on adjective	0.274
No definite suffix on adjective	Definite suffix on adjective	0.061
No obligatory definiteness	Obligatory definiteness on first member of NP	0.093
No obligatory definiteness	Obligatory definiteness on last member of NP	0.182
Obligatory definiteness on first member of NP	No obligatory definiteness	0.185
Obligatory definiteness on first member of NP	Obligatory definiteness on last member of NP	0.132
Obligatory definiteness on last member of NP	No obligatory definiteness	1.551
Obligatory definiteness on last member of NP	Obligatory definiteness on first member of NP	0.639
Definite article	No definite article	0.135
No definite article	Definite article	0.102
Definite suffix on noun	No definite suffix on noun	0.308
No definite suffix on noun	Definite suffix on noun	0.124
Fewer than five genders	More than five genders	0.017
More than five genders	Fewer than five genders	0.650
No noun class for animates	Noun class for animates	0.070
Noun class for animates	No noun class for animates	0.508
Masculine/feminine distinction	No masculine/feminine distinction	0.214
No masculine/feminine distinction	Masculine/feminine distinction	0.373
Neuter gender	No neuter gender	0.361

No neuter gender	Neuter gender	0.094
Gender on predicative adjective	No gender on predicative adjective	0.311
No gender on predicative adjective	Gender on predicative adjective	0.395
More than 7 cases	Not more than 7 cases	0.728
Not more than 7 cases	More than 7 cases	0.057
Agglutination for number	No agglutination for number	0.353
No agglutination for number	Agglutination for number	0.187
Agglutination for case	No agglutination for case	0.520
No agglutination for case	Agglutination for case	0.218
Dative but no genitive	Genitive and dative	1.332
Dative but no genitive	Genitive but no dative	1.218
Dative but no genitive	No genitive or dative	0.859
Genitive and dative	Dative but no genitive	0.165
Genitive and dative	Genitive but no dative	0.346
Genitive and dative	No genitive or dative	0.161
Genitive but no dative	Dative but no genitive	0.579
Genitive but no dative	Genitive and dative	0.930
Genitive but no dative	No genitive or dative	0.737
No genitive or dative	Dative but no genitive	0.164
No genitive or dative	Genitive and dative	0.137
No genitive or dative	Genitive but no dative	0.238
Case difference A and O	No case difference A and O	0.355
No case difference A and O	Case difference A and O	0.583
No peripheral cases	Peripheral cases	0.046
Peripheral cases	No peripheral cases	0.150
No Vocative	Vocative	0.128
Vocative	No Vocative	0.253
Agreement on prepositions	No agreement on prepositions	0.110
No agreement on prepositions	Agreement on prepositions	0.039
Fewer than 7 pronominal cases (pronouns)	More than 7 pronominal cases (pronouns)	0.038
More than 7 pronominal cases (pronouns)	Fewer than 7 pronominal cases (pronouns)	0.740
Agglutination for number (pronouns)	No agglutination for number (pronouns)	0.324
No agglutination for number (pronouns)	Agglutination for number (pronouns)	0.132
Agglutination for case (pronouns)	No agglutination for case (pronouns)	0.058
No agglutination for case (pronouns)	Agglutination for case (pronouns)	0.434
Difference A and O (pronouns)	No difference A and O (pronouns)	0.085
No difference A and O (pronouns)	Difference A and O (pronouns)	0.396
Difference, O and Dative (pronouns)	No difference O and Dative (pronouns)	0.535

No difference O and Dative (pronouns)	Difference, O and Dative (pronouns)	0.381
No peripheral cases (pronouns)	Peripheral cases (pronouns)	0.056
Peripheral cases (pronouns)	No peripheral cases (pronouns)	0.236
No Vocative (pronouns)	Vocative (pronouns)	0.019
Vocative (pronouns)	No Vocative (pronouns)	0.721
No synthetic Present progressive	Synthetic Present progressive	0.522
Synthetic Present progressive	No synthetic Present progressive	0.071
No Present progressive by auxiliary	Present progressive by auxiliary	0.270
Present progressive by auxiliary	No Present progressive by auxiliary	0.440
Future by auxiliary	No Future by auxiliary	0.463
No Future by auxiliary	Future by auxiliary	0.383
Future by participle	No Future by participle	0.653
No Future by participle	Future by participle	0.093
Future by particle	No Future by particle	0.581
No Future by particle	Future by particle	0.132
No synthetic Future	Synthetic Future	0.165
Synthetic Future	No synthetic Future	0.206
Future by perfect	No Future by perfect	0.360
No Future by perfect	Future by perfect	0.023
Present progressive: Full A Agreement	Present progressive: Full and Gender A Agreement	0.077
Present progressive: Full A Agreement	Present progressive: Gender A Agreement	0.112
Present progressive: Full A Agreement	Present progressive: No A Agreement	0.097
Present progressive: Full A Agreement	Present progressive: Syncretic A Agreement	0.207
Present progressive: Full and Gender A Agreement	Present progressive: Full A Agreement	1.548
Present progressive: Full and Gender A Agreement	Present progressive: Gender A Agreement	1.269
Present progressive: Full and Gender A Agreement	Present progressive: No A Agreement	1.367
Present progressive: Full and Gender A Agreement	Present progressive: Syncretic A Agreement	1.598
Present progressive: Gender A Agreement	Present progressive: Full A Agreement	1.350
Present progressive: Gender A Agreement	Present progressive: Full and Gender A Agreement	0.763
Present progressive: Gender A Agreement	Present progressive: No A Agreement	1.095

Present progressive:	Gender A	Present progressive:	Syncretic A	1.322
Agreement		Agreement		
Present progressive:	No A Agreement	Present progressive:	Full A Agreement	1.047
Present progressive:	No A Agreement	Present progressive:	Full and Gender A Agreement	0.586
Present progressive:	No A Agreement	Present progressive:	Gender A	0.807
Present progressive:	No A Agreement	Present progressive:	Syncretic A	1.355
Present progressive:	Syncretic A Agreement	Present progressive:	Full A Agreement	0.115
Present progressive:	Syncretic A Agreement	Present progressive:	Full and Gender A Agreement	0.109
Present progressive:	Syncretic A Agreement	Present progressive:	Gender A	0.147
Present progressive:	Syncretic A Agreement	Present progressive:	No A Agreement	0.352
Present progressive:	Full Dative Agreement	Present progressive:	No Dative Agreement	1.441
Present progressive:	Full Dative Agreement	Present progressive:	Syncretic Dative Agreement	1.328
Present progressive:	No Dative Agreement	Present progressive:	Full Dative Agreement	0.032
Present progressive:	No Dative Agreement	Present progressive:	Syncretic Dative Agreement	0.069
Present progressive:	Syncretic Dative Agreement	Present progressive:	Full Dative Agreement	0.457
Present progressive:	Syncretic Dative Agreement	Present progressive:	No Dative Agreement	0.669
Present progressive:	Full O Agreement	Present progressive:	No O Agreement	1.435
Present progressive:	Full O Agreement	Present progressive:	Syncretic O Agreement	1.329
Present progressive:	No O Agreement	Present progressive:	Full O Agreement	0.032
Present progressive:	No O Agreement	Present progressive:	Syncretic O Agreement	0.069
Present progressive:	Syncretic O Agreement	Present progressive:	Full O Agreement	0.454
Present progressive:	Syncretic O Agreement	Present progressive:	No O Agreement	0.661

Simple past: Full A Agreement	Simple past: Full and Gender A Agreement	1.733
Simple past: Full A Agreement	Simple past: Gender A Agreement	1.217
Simple past: Full A Agreement	Simple past: No A Agreement	1.299
Simple past: Full A Agreement	Simple past: Syncretic A Agreement	1.729
Simple past: Full and Gender A Agreement	Simple past: Full A Agreement	0.179
Simple past: Full and Gender A Agreement	Simple past: Gender A Agreement	0.236
Simple past: Full and Gender A Agreement	Simple past: No A Agreement	0.284
Simple past: Full and Gender A Agreement	Simple past: Syncretic A Agreement	0.822
Simple past: Gender A Agreement	Simple past: Full A Agreement	0.748
Simple past: Gender A Agreement	Simple past: Full and Gender A Agreement	1.432
Simple past: No A Agreement	Simple past: No A Agreement	1.011
Simple past: No A Agreement	Simple past: Syncretic A Agreement	1.422
Simple past: No A Agreement	Simple past: Full A Agreement	0.725
Simple past: No A Agreement	Simple past: Full and Gender A Agreement	1.524
Simple past: No A Agreement	Simple past: Gender A Agreement	0.923
Simple past: No A Agreement	Simple past: Syncretic A Agreement	1.527
Simple past: Syncretic A Agreement	Simple past: Full A Agreement	0.265
Simple past: Syncretic A Agreement	Simple past: Full and Gender A Agreement	1.143
Simple past: Syncretic A Agreement	Simple past: Gender A Agreement	0.364
Simple past: Syncretic A Agreement	Simple past: No A Agreement	0.443
Simple past: Full Dative Agreement	Simple past: Gender Dative Agreement	1.016
Simple past: Full Dative Agreement	Simple past: No Dative Agreement	1.462
Simple past: Full Dative Agreement	Simple past: Syncretic Dative Agreement	1.347
Simple past: Gender Dative Agreement	Simple past: Full Dative Agreement	1.005
Simple past: Gender Dative Agreement	Simple past: No Dative Agreement	1.490
Simple past: Gender Dative Agreement	Simple past: Syncretic Dative Agreement	1.378
Simple past: No Dative Agreement	Simple past: Full Dative Agreement	0.033
Simple past: No Dative Agreement	Simple past: Gender Dative Agreement	0.035

Simple past: No Dative Agreement	Simple past: Syncretic Dative Agreement	0.069
Simple past: Syncretic Dative Agreement	Simple past: Full Dative Agreement	0.468
Simple past: Syncretic Dative Agreement	Simple past: Gender Dative Agreement	0.461
Simple past: Syncretic Dative Agreement	Simple past: No Dative Agreement	0.678
Simple past: Gender and full O Agreement	Simple past: Gender O Agreement	1.097
Simple past: Gender and full O Agreement	Simple past: No O Agreement	1.109
Simple past: Gender and full O Agreement	Simple Past: Syncretic and gender A Agreement	1.350
Simple past: Gender and full O Agreement	Simple past: Syncretic O Agreement	1.355
Simple past: Gender O Agreement	Simple past: Gender and full O Agreement	0.924
Simple past: Gender O Agreement	Simple past: No O Agreement	1.008
Simple past: Gender O Agreement	Simple Past: Syncretic and gender A Agreement	1.268
Simple past: Gender O Agreement	Simple past: Syncretic O Agreement	1.285
Simple past: No O Agreement	Simple past: Gender and full O Agreement	0.052
Simple past: No O Agreement	Simple past: Gender O Agreement	0.056
Simple past: No O Agreement	Simple Past: Syncretic and gender A Agreement	0.073
Simple past: No O Agreement	Simple past: Syncretic O Agreement	0.092
Simple Past: Syncretic and gender A Agreement	Simple past: Gender and full O Agreement	0.584
Simple Past: Syncretic and gender A Agreement	Simple past: Gender O Agreement	0.653
Simple Past: Syncretic and gender A Agreement	Simple past: No O Agreement	0.623
Simple Past: Syncretic and gender A Agreement	Simple past: Syncretic O Agreement	0.886
Simple past: Syncretic O Agreement	Simple past: Gender and full O Agreement	0.474
Simple past: Syncretic O Agreement	Simple past: Gender O Agreement	0.530
Simple past: Syncretic O Agreement	Simple past: No O Agreement	0.439
Simple past: Syncretic O Agreement	Simple Past: Syncretic and gender A Agreement	0.733

No Postpositions	Postpositions	0.034
Postpositions	No Postpositions	0.085
No Prepositions	Prepositions	0.060
Prepositions	No Prepositions	0.037
Clitic finite V: Category irrelevant	Clitic finite V: OV	0.076
Clitic finite V: Category irrelevant	Clitic finite V: V2	0.117
Clitic finite V: Category irrelevant	Clitic finite V: VO	0.543
Clitic finite V: Category irrelevant	Clitic finite V: VO and OV	0.097
Clitic finite V: OV	Clitic finite V: Category irrelevant	0.376
Clitic finite V: OV	Clitic finite V: V2	0.123
Clitic finite V: OV	Clitic finite V: VO	0.174
Clitic finite V: OV	Clitic finite V: VO and OV	0.130
Clitic finite V: V2	Clitic finite V: Category irrelevant	0.762
Clitic finite V: V2	Clitic finite V: OV	0.242
Clitic finite V: V2	Clitic finite V: VO	0.612
Clitic finite V: V2	Clitic finite V: VO and OV	0.431
Clitic finite V: VO	Clitic finite V: Category irrelevant	1.187
Clitic finite V: VO	Clitic finite V: OV	0.240
Clitic finite V: VO	Clitic finite V: V2	0.563
Clitic finite V: VO	Clitic finite V: VO and OV	0.364
Clitic finite V: VO and OV	Clitic finite V: Category irrelevant	0.833
Clitic finite V: VO and OV	Clitic finite V: OV	0.517
Clitic finite V: VO and OV	Clitic finite V: V2	0.836
Clitic finite V: VO and OV	Clitic finite V: VO	0.778
Clitic Infinitive V: Category irrelevant	Clitic Infinitive V: OV	0.096
Clitic Infinitive V: Category irrelevant	Clitic Infinitive V: V2	0.062
Clitic Infinitive V: Category irrelevant	Clitic Infinitive V: VO	0.097
Clitic Infinitive V: Category irrelevant	Clitic Infinitive V: VO and OV	0.081
Clitic Infinitive V: OV	Clitic Infinitive V: Category irrelevant	0.316
Clitic Infinitive V: OV	Clitic Infinitive V: V2	0.625
Clitic Infinitive V: OV	Clitic Infinitive V: VO	0.668
Clitic Infinitive V: V2	Clitic Infinitive V: VO and OV	0.388
Clitic Infinitive V: V2	Clitic Infinitive V: Category irrelevant	0.563
Clitic Infinitive V: V2	Clitic Infinitive V: OV	0.626
Clitic Infinitive V: V2	Clitic Infinitive V: VO	0.412
Clitic Infinitive V: V2	Clitic Infinitive V: VO and OV	0.426

Clitic Infinitive V: VO	Clitic Infinitive V: Category irrelevant	0.170
Clitic Infinitive V: VO	Clitic Infinitive V: OV	0.940
Clitic Infinitive V: VO	Clitic Infinitive V: V2	0.345
Clitic Infinitive V: VO	Clitic Infinitive V: VO and OV	0.272
Clitic Infinitive V: VO and OV	Clitic Infinitive V: Category irrelevant	1.434
Clitic Infinitive V: VO and OV	Clitic Infinitive V: OV	1.263
Clitic Infinitive V: VO and OV	Clitic Infinitive V: V2	1.191
Clitic Infinitive V: VO and OV	Clitic Infinitive V: VO	1.054
Clitic Participle V: Category irrelevant	Clitic Participle V: OV	0.139
Clitic Participle V: Category irrelevant	Clitic Participle V: V2	0.090
Clitic Participle V: Category irrelevant	Clitic Participle V: VO	0.116
Clitic Participle V: Category irrelevant	Clitic Participle V: VO and OV	0.101
Clitic Participle V: OV	Clitic Participle V: Category irrelevant	0.494
Clitic Participle V: OV	Clitic Participle V: V2	0.433
Clitic Participle V: OV	Clitic Participle V: VO	0.595
Clitic Participle V: OV	Clitic Participle V: VO and OV	0.361
Clitic Participle V: V2	Clitic Participle V: Category irrelevant	0.604
Clitic Participle V: V2	Clitic Participle V: OV	0.759
Clitic Participle V: V2	Clitic Participle V: VO	0.561
Clitic Participle V: V2	Clitic Participle V: VO and OV	0.475
Clitic Participle V: VO	Clitic Participle V: Category irrelevant	0.233
Clitic Participle V: VO	Clitic Participle V: OV	0.821
Clitic Participle V: VO	Clitic Participle V: V2	0.512
Clitic Participle V: VO	Clitic Participle V: VO and OV	0.408
Clitic Participle V: VO and OV	Clitic Participle V: Category irrelevant	0.864
Clitic Participle V: VO and OV	Clitic Participle V: OV	1.317
Clitic Participle V: VO and OV	Clitic Participle V: V2	1.111
Clitic Participle V: VO and OV	Clitic Participle V: VO	1.687
Infinitive: Category irrelevant	Infinitive: OV	0.545
Infinitive: Category irrelevant	Infinitive: OV and VO	0.532
Infinitive: Category irrelevant	Infinitive: VO	0.577
Infinitive: OV	Infinitive: Category irrelevant	0.038

Infinitive: OV	Infinitive: OV and VO	0.038
Infinitive: OV	Infinitive: VO	0.075
Infinitive: OV and VO	Infinitive: Category irrelevant	1.365
Infinitive: OV and VO	Infinitive: OV	0.567
Infinitive: OV and VO	Infinitive: VO	0.757
Infinitive: VO	Infinitive: Category irrelevant	0.106
Infinitive: VO	Infinitive: OV	0.080
Infinitive: VO	Infinitive: OV and VO	0.151
Main clause: SOV	Main clause: SOV/SVO	0.047
Main clause: SOV	Main clause: SVO	0.043
Main clause: SOV	Main clause: V2	0.035
Main clause: SOV	Main clause: VSO	0.031
Main clause: SOV/SVO	Main clause: SOV	1.082
Main clause: SOV/SVO	Main clause: SVO	1.547
Main clause: SOV/SVO	Main clause: V2	1.331
Main clause: SOV/SVO	Main clause: VSO	0.969
Main clause: SVO	Main clause: SOV	0.048
Main clause: SVO	Main clause: SOV/SVO	0.078
Main clause: SVO	Main clause: V2	0.197
Main clause: SVO	Main clause: VSO	0.057
Main clause: V2	Main clause: SOV	0.086
Main clause: V2	Main clause: SOV/SVO	0.133
Main clause: V2	Main clause: SVO	0.423
Main clause: V2	Main clause: VSO	0.145
Main clause: VSO	Main clause: SOV	0.419
Main clause: VSO	Main clause: SOV/SVO	0.451
Main clause: VSO	Main clause: SVO	0.540
Main clause: VSO	Main clause: V2	0.491
Noun - Possessor	Possessor - Noun	0.154
Noun - Possessor	Possessor - Noun and Noun - Possessor	0.159
Possessor - Noun	Noun - Possessor	0.088
Possessor - Noun	Possessor - Noun and Noun - Possessor	0.054
Possessor - Noun and Noun - Possessor	Noun - Possessor	0.929
Possessor - Noun and Noun - Possessor	Possessor - Noun	0.689
Adjective - Noun	Adjective - Noun and Noun - Adjective	0.086
Adjective - Noun	Noun - Adjective	0.024
Adjective - Noun and Noun - Adjective	Adjective - Noun	0.775

Adjective - Noun and Noun - Adjective	Noun - Adjective	1.035
Noun - Adjective	Adjective - Noun	0.079
Noun - Adjective	Adjective - Noun and Noun - Adjective	0.253
NRel: Category irrelevant	NRel: Noun - Relative	1.470
NRel: Category irrelevant	NRel: Relative - Noun	1.526
NRel: Category irrelevant	NRel: Relative - Noun and Noun - Relative	1.045
NRel: Noun - Relative	NRel: Category irrelevant	0.046
NRel: Noun - Relative	NRel: Relative - Noun	0.030
NRel: Noun - Relative	NRel: Relative - Noun and Noun - Relative	0.030
NRel: Relative - Noun	NRel: Category irrelevant	0.160
NRel: Relative - Noun	NRel: Noun - Relative	0.210
NRel: Relative - Noun	NRel: Relative - Noun and Noun - Relative	0.221
NRel: Relative - Noun and Noun - Relative	NRel: Category irrelevant	0.962
NRel: Relative - Noun and Noun - Relative	NRel: Noun - Relative	1.271
NRel: Relative - Noun and Noun - Relative	NRel: Relative - Noun	1.595
O - Participle	Participle - O	0.081
O - Participle	Participle - O and O - Participle	0.036
Participle - O	O - Participle	0.091
Participle - O	Participle - O and O - Participle	0.066
Participle - O and O - Participle	O - Participle	0.392
Participle - O and O - Participle	Participle - O	0.334
Subordinate clause: SOV	Subordinate clause: SOV and SVO	0.048
Subordinate clause: SOV	Subordinate clause: SVO	0.059
Subordinate clause: SOV	Subordinate clause: V2	0.054
Subordinate clause: SOV	Subordinate clause: VSO	0.028
Subordinate clause: SOV and SVO	Subordinate clause: SOV	1.322
Subordinate clause: SOV and SVO	Subordinate clause: SVO	1.398
Subordinate clause: SOV and SVO	Subordinate clause: V2	1.053
Subordinate clause: SOV and SVO	Subordinate clause: VSO	1.012
Subordinate clause: SVO	Subordinate clause: SOV	0.078
Subordinate clause: SVO	Subordinate clause: SOV and SVO	0.064
Subordinate clause: SVO	Subordinate clause: V2	0.053
Subordinate clause: SVO	Subordinate clause: VSO	0.051
Subordinate clause: V2	Subordinate clause: SOV	0.311

Subordinate clause: V2	Subordinate clause: SOV and SVO	0.407
Subordinate clause: V2	Subordinate clause: SVO	0.992
Subordinate clause: V2	Subordinate clause: VSO	0.309
Subordinate clause: VSO	Subordinate clause: SOV	0.303
Subordinate clause: VSO	Subordinate clause: SOV and SVO	0.247
Subordinate clause: VSO	Subordinate clause: SVO	0.199
Subordinate clause: VSO	Subordinate clause: V2	0.208
No WH - Verb (initial or not)	WH - Verb (initial or not)	0.267
WH - Verb (initial or not)	No WH - Verb (initial or not)	0.253
No WH-initial (no inversion)	WH-initial (no inversion)	0.213
WH-initial (no inversion)	No WH-initial (no inversion)	0.219

S6

Entry and exit (gain and loss) rates of features. Type = A (alignment), NM (nominal morphology), T (tense), VM (verbal morphology), WO (word order).

Type	Feature	Entry rate	Exit rate
A1	Present-Past: A marking in Present Progressive and Past	1.087	0.385
A2	Present-Past: Active-ergative in Present Progressive and Past	0.232	1.503
A3	Present-Past: All systems	0.333	3.032
A4	Present-Past: No marking difference	0.136	4.647
A5	Noun, Present progressive: No marking	0.642	1.219
A6	Noun, Present progressive: Nominative-accusative	1.112	0.675
A7	Noun, Present progressive: Tripartite	0.115	3.383
A8	Noun, Simple past: Ergative	0.231	1.209
A9	Noun, Simple past: No marking	0.692	1.582
A10	Noun, Simple past: Nominative-accusative	0.959	0.960
A11	Noun, Simple past: Tripartite	0.162	4.421
A12	Pronoun, Present progressive: No marking	0.118	0.807
A13	Pronoun, Present progressive: Nominative-accusative	0.807	0.118
A14	Pronoun, Simple past: Ergative	0.224	0.938
A15	Pronoun, Simple past: No marking	0.217	1.973
A16	Pronoun, Simple past: Nominative-accusative	0.527	0.259
A17	Pronoun, Simple past: Tripartite	0.154	3.964
A18	Reflexive not with Agent	0.042	0.888
A19	Reflexive with Agent	0.888	0.042
A20	Reflexive not with Object	0.548	0.035
A21	Reflexive with Object	0.035	0.548
A22	Verb, Present progressive: A=O/So=O	0.101	4.038
A23	Verb, Present progressive: No marking	0.195	2.874
A24	Verb, Present progressive: Nominative-Accusative	1.446	0.211
A25	Verb, Present progressive: Tripartite	0.120	2.912
A26	Verb, Simple past: Double oblique	0.183	5.646
A27	Verb, Simple past: Ergative	0.303	2.078
A28	Verb, Simple past: No marking	0.448	3.451
A29	Verb, Simple past: Nominative-accusative	0.981	0.562
A30	Verb, Simple past: Tripartite	0.298	2.998
NM1	Case on adjective	0.408	0.562
NM2	No case on adjective	0.562	0.408
NM3	Case on article	0.182	0.722
NM4	No case on article	0.722	0.182
NM5	Case on last member of NP	0.138	0.258
NM6	No rule of case on last/first member of NP	0.258	0.138
NM7	Case on noun	0.718	0.316

NM8	No case on noun	0.316	0.718
NM9	Definite suffix on adjective	0.061	0.274
NM10	No definite suffix on adjective	0.274	0.061
NM11	No obligatory definiteness	0.431	0.275
NM12	Obligatory definiteness on first member of NP	0.149	0.318
NM13	Obligatory definiteness on last member of NP	0.165	2.191
NM14	Definite article	0.102	0.135
NM15	No definite article	0.135	0.102
NM16	Definite suffix on noun	0.124	0.308
NM17	No definite suffix on noun	0.308	0.124
NM18	Fewer than five genders	0.650	0.017
NM19	More than five genders	0.017	0.650
NM20	No noun class for animates	0.508	0.070
NM21	Noun class for animates	0.070	0.508
NM22	Masculine/feminine distinction	0.373	0.214
NM23	No masculine/feminine distinction	0.214	0.373
NM24	Neuter gender	0.094	0.361
NM25	No neuter gender	0.361	0.094
NM26	Gender on predicative adjective	0.395	0.311
NM27	No gender on predicative adjective	0.311	0.395
NM28	More than 7 cases	0.057	0.728
NM29	Not more than 7 cases	0.728	0.057
NM30	Agglutination for number	0.187	0.353
NM31	No agglutination for number	0.353	0.187
NM32	Agglutination for case	0.218	0.520
NM33	No agglutination for case	0.520	0.218
NM34	Dative but no genitive	0.225	3.409
NM35	Genitive and dative	0.440	0.673
NM36	Genitive but no dative	0.358	2.247
NM37	No genitive or dative	0.367	0.540
NM38	Case difference A and O	0.583	0.355
NM39	No case difference A and O	0.355	0.583
NM40	No peripheral cases	0.150	0.046
NM41	Peripheral cases	0.046	0.150
NM42	No Vocative	0.253	0.128
NM43	Vocative	0.128	0.253
NM44	Agreement on prepositions	0.039	0.110
NM45	No agreement on prepositions	0.110	0.039
NM46	Fewer than 7 pronominal cases (pronouns)	0.740	0.038
NM47	More than 7 pronominal cases (pronouns)	0.038	0.740
NM48	Agglutination for number (pronouns)	0.132	0.324
NM49	No agglutination for number (pronouns)	0.324	0.132

NM50	Agglutination for case (pronouns)	0.434	0.058
NM51	No agglutination for case (pronouns)	0.058	0.434
NM52	Difference A and O (pronouns)	0.396	0.085
NM53	No difference A and O (pronouns)	0.085	0.396
NM54	Difference, O and Dative (pronouns)	0.381	0.535
NM55	No difference O and Dative (pronouns)	0.535	0.381
NM56	No peripheral cases (pronouns)	0.236	0.056
NM57	Peripheral cases (pronouns)	0.056	0.236
NM58	No Vocative (pronouns)	0.721	0.019
NM59	Vocative (pronouns)	0.019	0.721
T1	No synthetic Present progressive	0.071	0.522
T2	Synthetic Present progressive	0.522	0.071
T3	No Present progressive by auxiliary	0.440	0.270
T4	Present progressive by auxiliary	0.270	0.440
T5	Future by auxiliary	0.383	0.463
T6	No Future by auxiliary	0.463	0.383
T7	Future by participle	0.093	0.653
T8	No Future by participle	0.653	0.093
T9	Future by particle	0.132	0.581
T10	No Future by particle	0.581	0.132
T11	No synthetic Future	0.206	0.165
T12	Synthetic Future	0.165	0.206
T13	Future by perfect	0.023	0.360
T14	No Future by perfect	0.360	0.023
VM1	Present progressive: Full A Agreement	0.408	0.494
VM2	Present progressive: Full and Gender A Agreement	0.159	5.784
VM3	Present progressive: Gender A Agreement	0.211	4.530
VM4	Present progressive: No A Agreement	0.293	3.796
VM5	Present progressive: Syncretic A Agreement	0.491	0.724
VM6	Present progressive: Full Dative Agreement	0.068	2.770
VM7	Present progressive: No Dative Agreement	0.842	0.102
VM8	Present progressive: Syncretic Dative Agreement	0.103	1.127
VM9	Present progressive: Full O Agreement	0.068	2.764
VM10	Present progressive: No O Agreement	0.833	0.101
VM11	Present progressive: Syncretic O Agreement	0.102	1.116
VM12	Simple past: Full A Agreement	0.247	7.639
VM13	Simple past: Full and Gender A Agreement	0.766	2.130
VM14	Simple past: Gender A Agreement	0.308	5.932
VM15	Simple past: No A Agreement	0.352	6.085
VM16	Simple past: Syncretic A Agreement	0.784	2.993
VM17	Simple past: Full Dative Agreement	0.091	3.825
VM18	Simple past: Gender Dative Agreement	0.092	3.874

VM19	Simple past: No Dative Agreement	0.978	0.138
VM20	Simple past: Syncretic Dative Agreement	0.134	1.607
VM21	Simple past: Gender and full O Agreement	0.194	4.912
VM22	Simple past: Gender O Agreement	0.211	4.485
VM23	Simple past: No O Agreement	0.673	0.273
VM24	Simple Past: Syncretic and gender A Agreement	0.270	2.748
VM25	Simple past: Syncretic O Agreement	0.287	2.177
VM26	No Postpositions	0.085	0.034
WO1	Postpositions	0.034	0.085
WO2	No Prepositions	0.037	0.060
WO3	Prepositions	0.060	0.037
WO4	Ctic finite V: Category irrelevant	0.786	0.835
WO5	Ctic finite V: OV	0.165	0.805
WO6	Ctic finite V: V2	0.254	2.048
WO7	Ctic finite V: VO	0.493	2.355
WO8	Ctic finite V: VO and OV	0.192	2.965
WO9	Ctic Infinitive V: Category irrelevant	0.429	0.338
WO10	Ctic Infinitive V: OV	0.358	1.999
WO11	Ctic Infinitive V: V2	0.252	2.029
WO12	Ctic Infinitive V: VO	0.281	1.729
WO13	Ctic Infinitive V: VO and OV	0.197	4.943
WO14	Ctic Participle V: Category irrelevant	0.471	0.447
WO15	Ctic Participle V: OV	0.414	1.884
WO16	Ctic Participle V: V2	0.285	2.400
WO17	Ctic Participle V: VO	0.360	1.975
WO18	Ctic Participle V: VO and OV	0.241	4.980
WO19	Infinitive: Category irrelevant	0.119	1.655
WO20	Infinitive: OV	0.196	0.152
WO21	Infinitive: OV and VO	0.112	2.691
WO22	Infinitive: VO	0.166	0.339
WO23	Main clause: SOV	0.115	0.158
WO24	Main clause: SOV/SVO	0.089	4.931
WO25	Main clause: SVO	0.211	0.381
WO26	Main clause: V2	0.153	0.788
WO27	Main clause: VSO	0.077	1.902
WO28	Noun - Possessor	0.154	0.313
WO29	Possessor - Noun	0.228	0.142
WO30	Possessor - Noun and Noun - Possessor	0.091	1.618
WO31	Adjective - Noun	0.223	0.110
WO32	Adjective - Noun and Noun - Adjective	0.133	1.811
WO33	Noun - Adjective	0.118	0.333
WO34	NRel: Category irrelevant	0.082	4.043

WO35	NRel: Noun - Relative	0.458	0.107
WO36	NRel: Relative - Noun	0.103	0.592
WO37	NRel: Relative - Noun and Noun - Relative	0.080	3.829
WO38	O - Participle	0.132	0.118
WO39	Participle - O	0.109	0.158
WO40	Participle - O and O - Participle	0.049	0.726
WO41	Subordinate clause: SOV	0.161	0.191
WO42	Subordinate clause: SOV and SVO	0.082	4.786
WO43	Subordinate clause: SVO	0.178	0.246
WO44	Subordinate clause: V2	0.082	2.020
WO45	Subordinate clause: VSO	0.068	0.958
WO46	No WH - Verb (initial or not)	0.253	0.267
WO47	WH - Verb (initial or not)	0.267	0.253
WO48	No WH-initial (no inversion)	0.219	0.213
WO49	WH-initial (no inversion)	0.213	0.219

S7

List of pairwise organized features, which are identified to be in a relation by a marking hierarchy. Feature 1 = Trait higher in hierarchy (more frequent, unmarked); Feature 2 = trait lower in hierarchy (less frequent, marked); Type = type of property distinguishing hierarchical relation between traits.

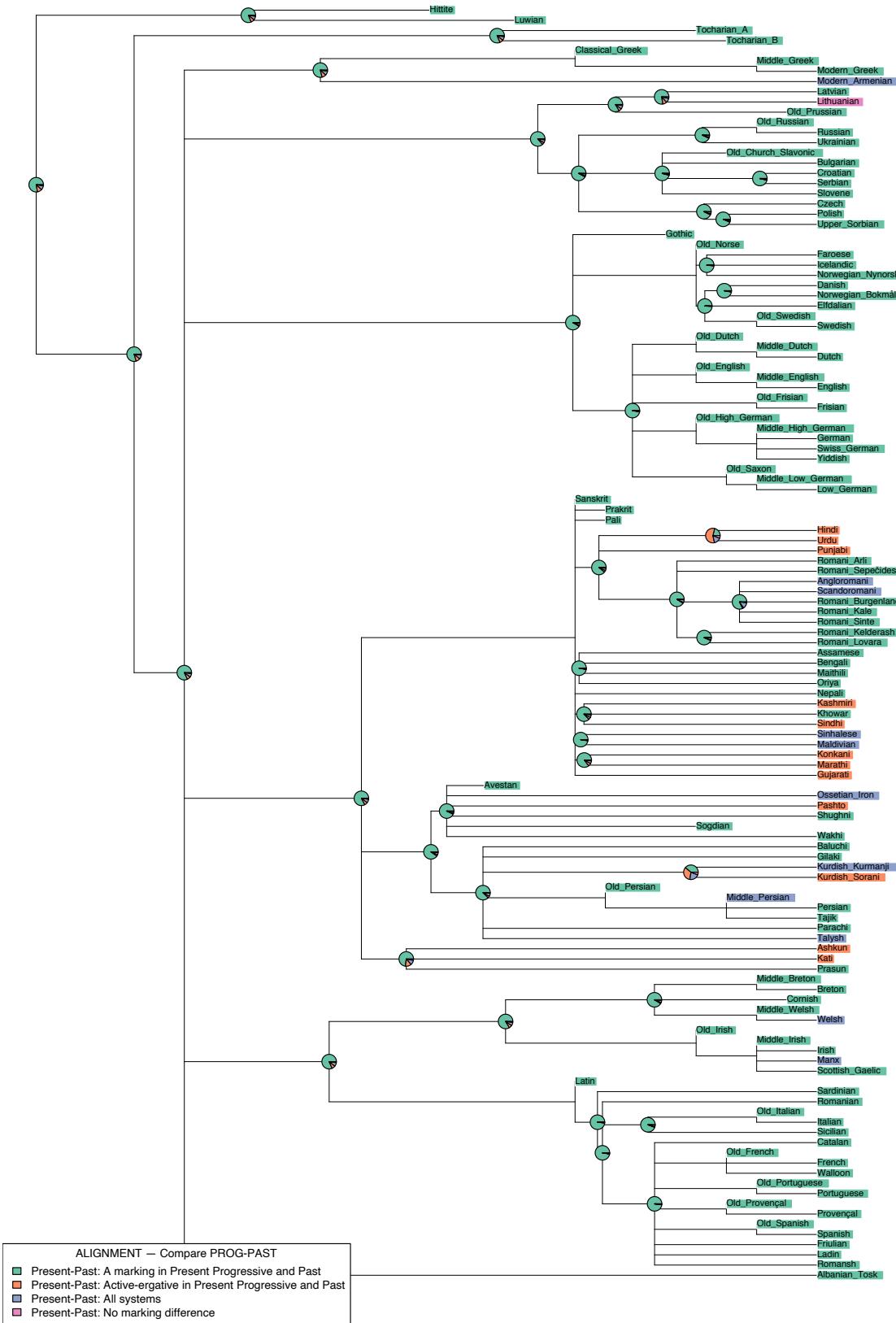
Feature 1 (Unmarked)	ID 1	Feature 2 (Marked)	ID 2	Type
Pronoun, Present progressive: Nominative-accusative	A13	Noun, Present progressive: Nominative-accusative	A6	pronoun < noun
Pronoun, Present progressive: No marking	A14	Noun, Present progressive: No marking	A7	pronoun < noun
Pronoun, Simple past: Nominative-accusative	A16	Noun, Simple past: Nominative-accusative	A9	pronoun < noun
Pronoun, Simple past: No marking	A19	Noun, Simple past: No marking	A11	pronoun < noun
Pronoun, Simple past: Ergative	A18	Noun, Simple past: Ergative	A10	pronoun < noun
Pronoun, Simple past: Tripartite	A15	Noun, Simple past: Tripartite	A8	pronoun < noun
Agglutination for case (pronouns)	NM51	Agglutination for case	NM33	pronoun < noun
Agglutination for number (pronouns)	NM50	Agglutination for number	NM31	pronoun < noun
No agglutination for case (pronouns)	NM52	No agglutination for case	NM32	pronoun < noun
No agglutination for number (pronouns)	NM49	No agglutination for number	NM30	pronoun < noun
Difference A and O (pronouns)	NM54	Case difference A and O	NM40	pronoun < noun
No peripheral cases (pronouns)	NM57	Peripheral cases	NM42	pronoun < noun
Difference, O and Dative (pronouns)	NM56	No peripheral cases	NM41	pronoun < noun
Vocative (pronouns)	NM60	Vocative	NM44	pronoun < noun
No Vocative (pronouns)	NM59	No Vocative	NM43	pronoun < noun
More than 7 pronominal cases	NM48	More than 7 cases	NM29	pronoun < noun
Less than 7 pronominal cases	NM47	Not more than 7 cases	NM28	pronoun < noun
Synthetic Present progressive	T2	Synthetic Future	T12	present < future

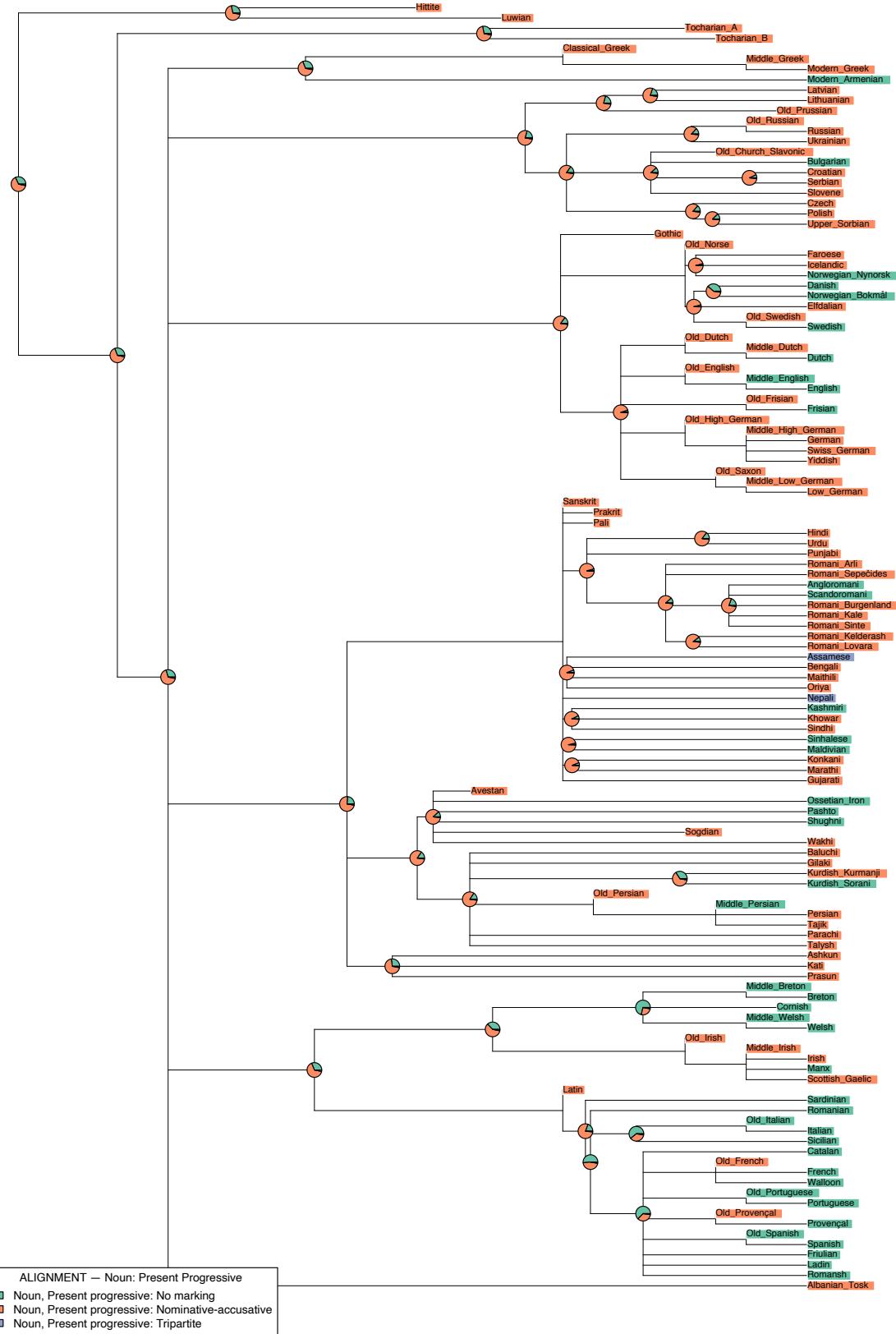
No synthetic Present progressive	T1	No synthetic Future	T11	present < future
Present progressive by auxiliary	T4	Future by auxiliary	T6	present < future
No Present progressive by auxiliary	T3	No Future by auxiliary	T5	present < future
Pronoun, Present progressive: Nominative-accusative	A13	Pronoun, Simple past: Nominative-accusative	A16	present < past
Pronoun, Present progressive: No marking	A14	Pronoun, Simple past: No marking	A19	present < past
Noun, Present progressive: A6 Nominative-accusative	A6	Noun, Simple past: A9 Nominative-accusative	A9	present < past
Noun, Present progressive: A7 No marking	A7	Noun, Simple past: No marking	A11	present < past
Noun, Present progressive: A5 Tripartite	A5	Noun, Simple past: Tripartite	A8	present < past
Verb, Present progressive: A25 Nominative-Accusative	A25	Verb, Simple past: A28 Nominative-accusative	A28	present < past
Verb, Present progressive: A26 No marking	A26	Verb, Simple past: No marking	A30	present < past
Verb, Present progressive: A24 Tripartite	A24	Verb, Simple past: Tripartite	A27	present < past
Present progressive: Syncretic A Agreement	VM1	Simple past: Syncretic A Agreement	VM12	present < past
Present progressive: No A Agreement	VM2	Simple past: No A Agreement	VM13	present < past
Present progressive: Gender A Agreement	VM3	Simple past: Gender A Agreement	VM14	present < past
Present progressive: Full A Agreement	VM4	Simple past: Full A Agreement	VM16	present < past
Present progressive: Full and Gender A Agreement	VM5	Simple past: Full and Gender A Agreement	VM17	present < past
Present progressive: Syncretic Dative Agreement	VM6	Simple past: Syncretic Dative Agreement	VM18	present < past
Present progressive: No Dative Agreement	VM7	Simple past: No Dative Agreement	VM19	present < past
Present progressive: Full Dative Agreement	VM8	Simple past: Full Dative Agreement	VM21	present < past
Present progressive: Syncretic O Agreement	VM9	Simple past: Syncretic O Agreement	VM22	present < past
Present progressive: No O Agreement	VM11	Simple past: No O Agreement	VM25	present < past

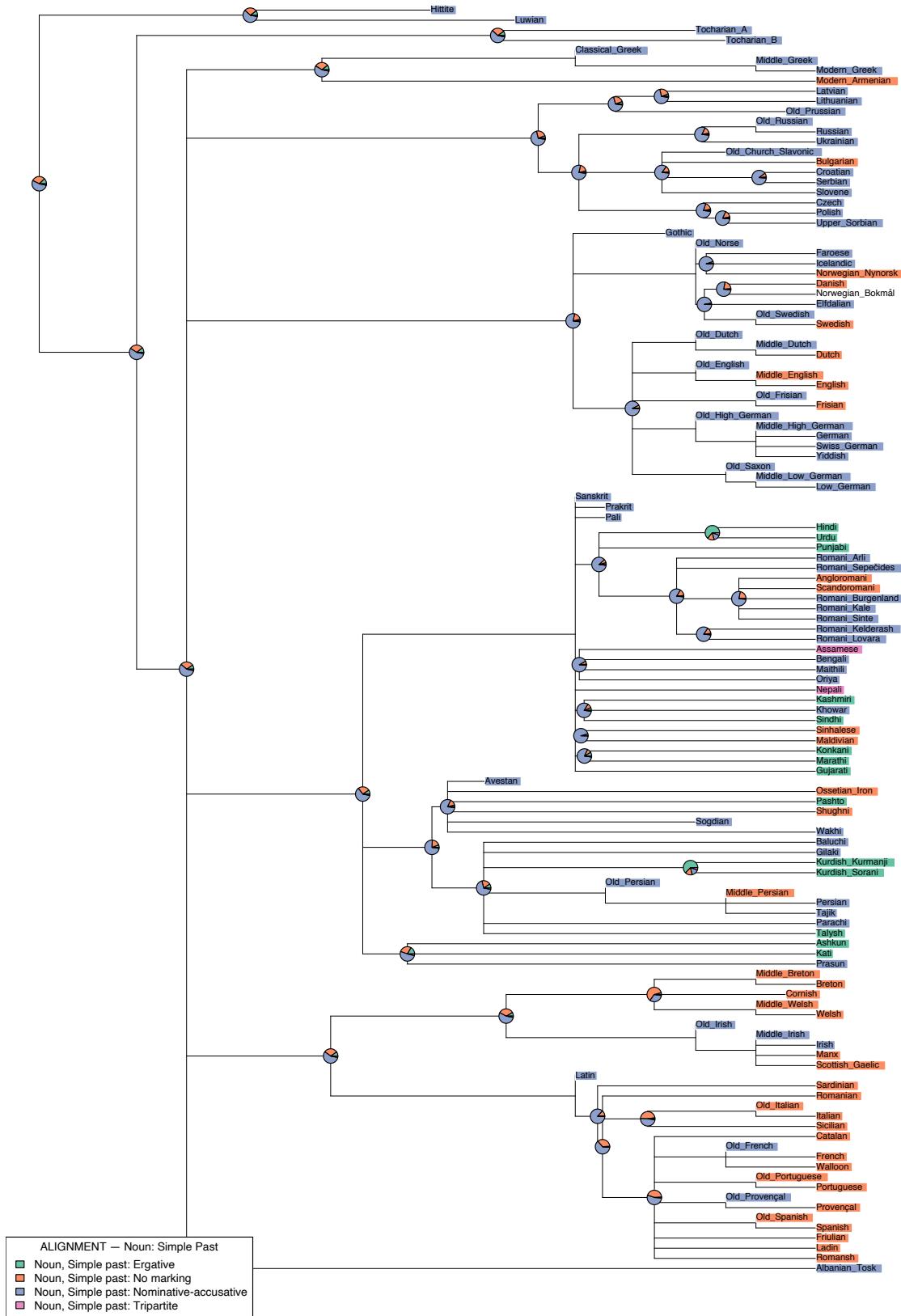
Reflexive with Agent	A21 Reflexive with Object	A23 agent < object
Reflexive not with Agent	A20 Reflexive not with Object	A22 agent < object
Case difference A and O	NM40 Genitive and dative	NM38 agent/object < oblique
Difference A and O (pronouns)	NM54 Difference, O and Dative (pronouns)	NM56 agent/object < oblique
No difference A and O (pronouns)	NM53 No difference O and Dative (pronouns)	NM55 agent/object < oblique
Masculine/feminine distinction	NM23 Neuter gender	NM25 masculine/feminine < neuter
No masculine/feminine distinction	NM22 No neuter gender	NM24 masculine/feminine < neuter

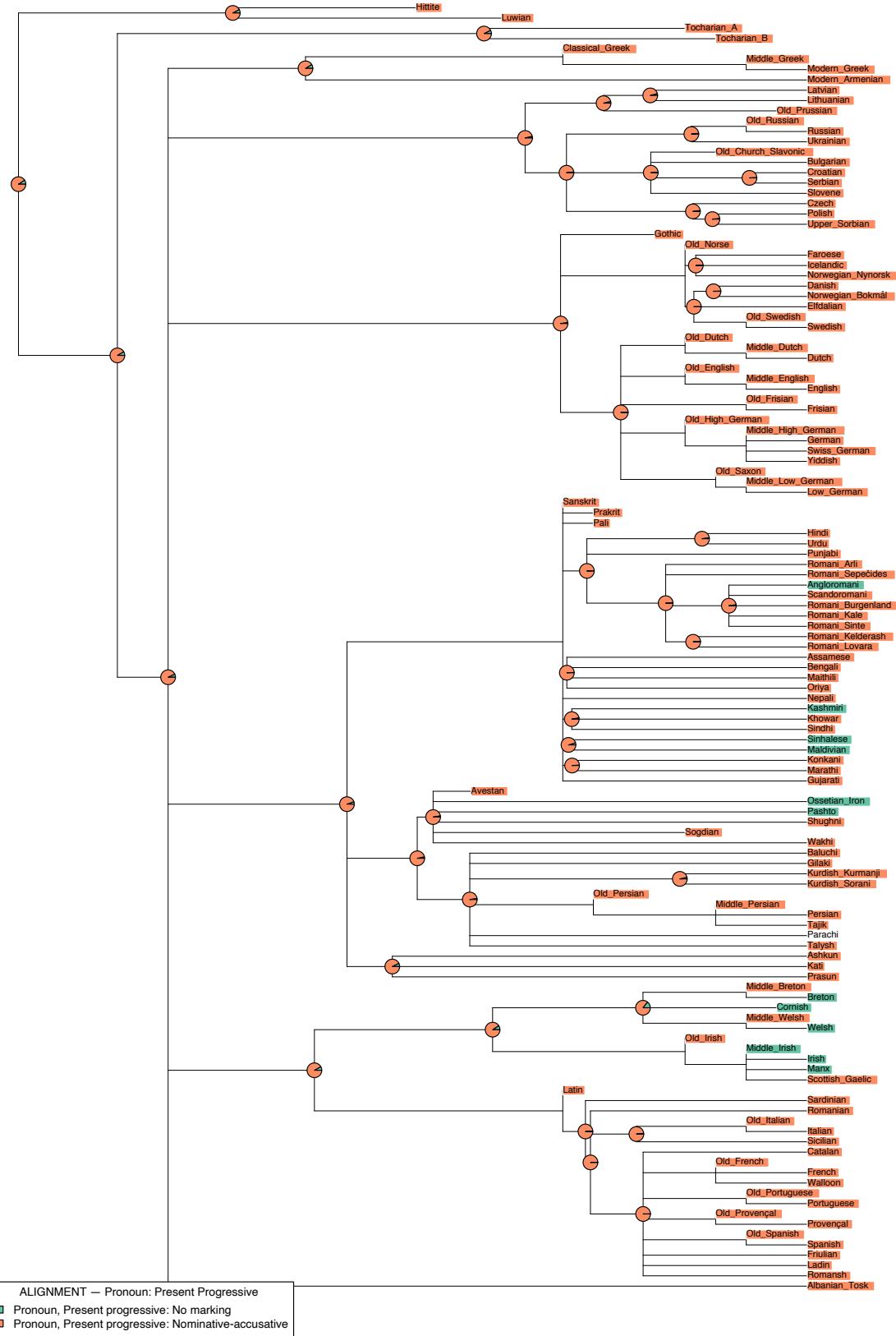
S8

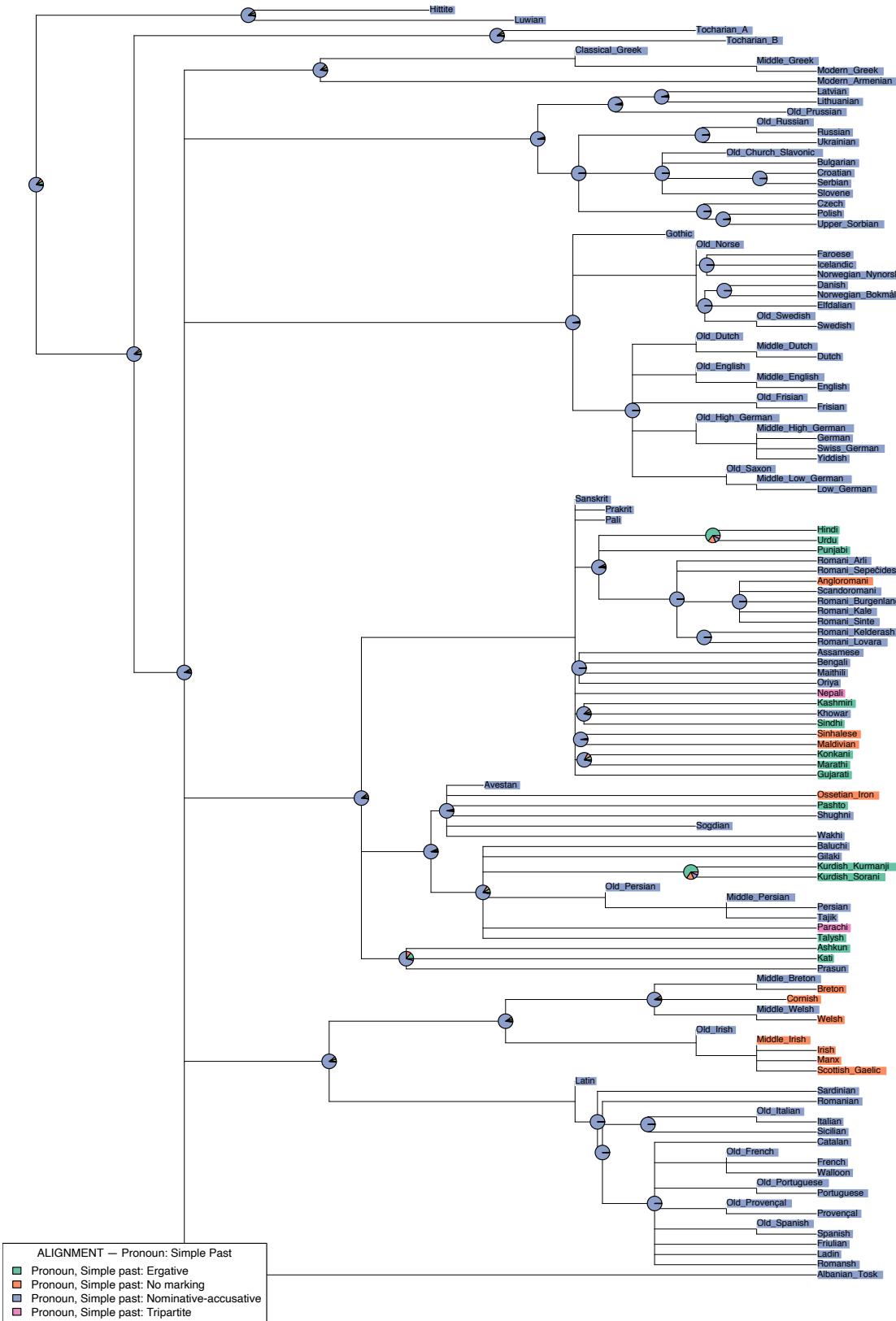
Reconstructed probability distributions of variables in our data set over all nodes of the phylogeny, visualized on a maximum clade credibility (MCC) tree of Indo-European. Labels lacking color indicate languages with missing data in our sample.

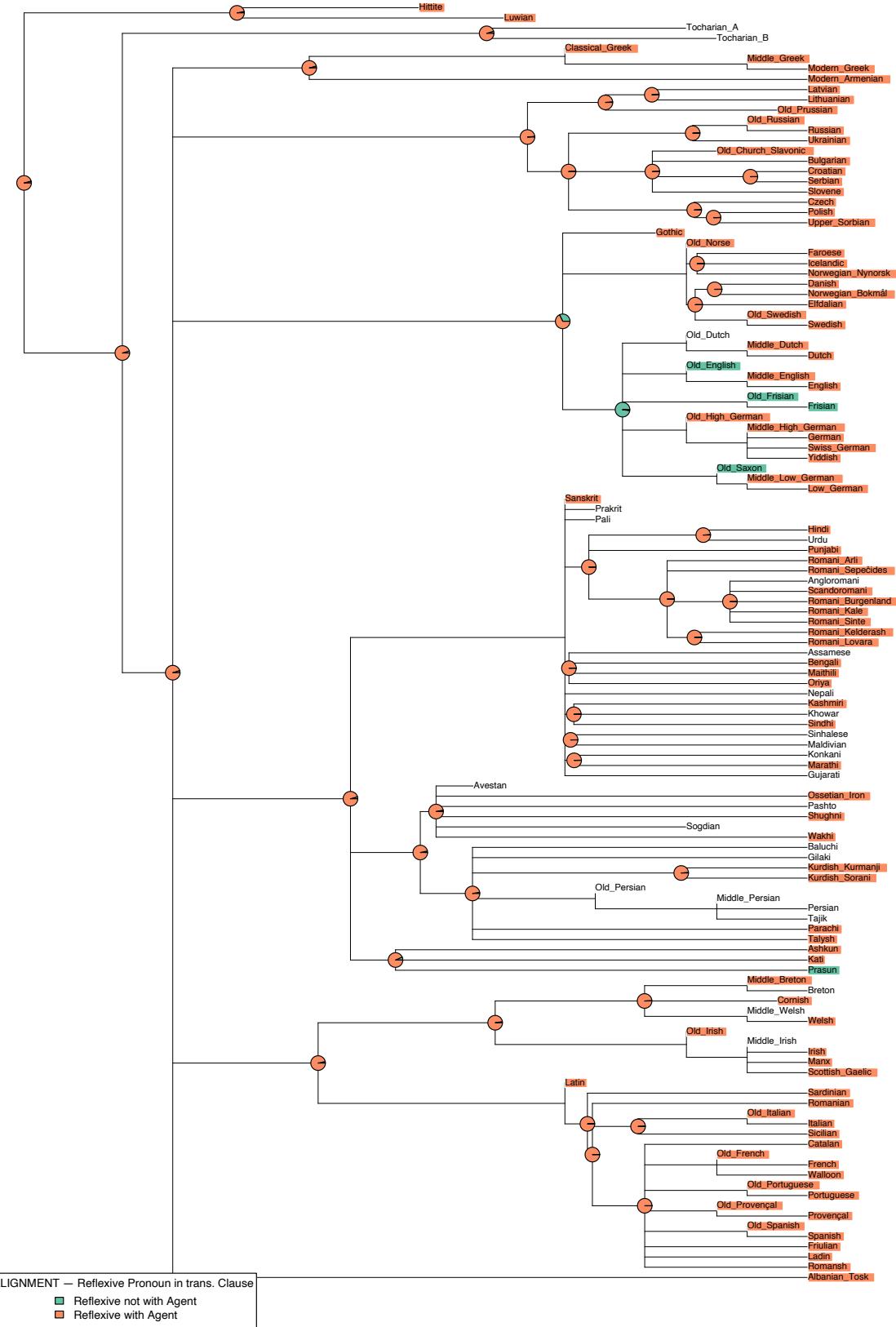


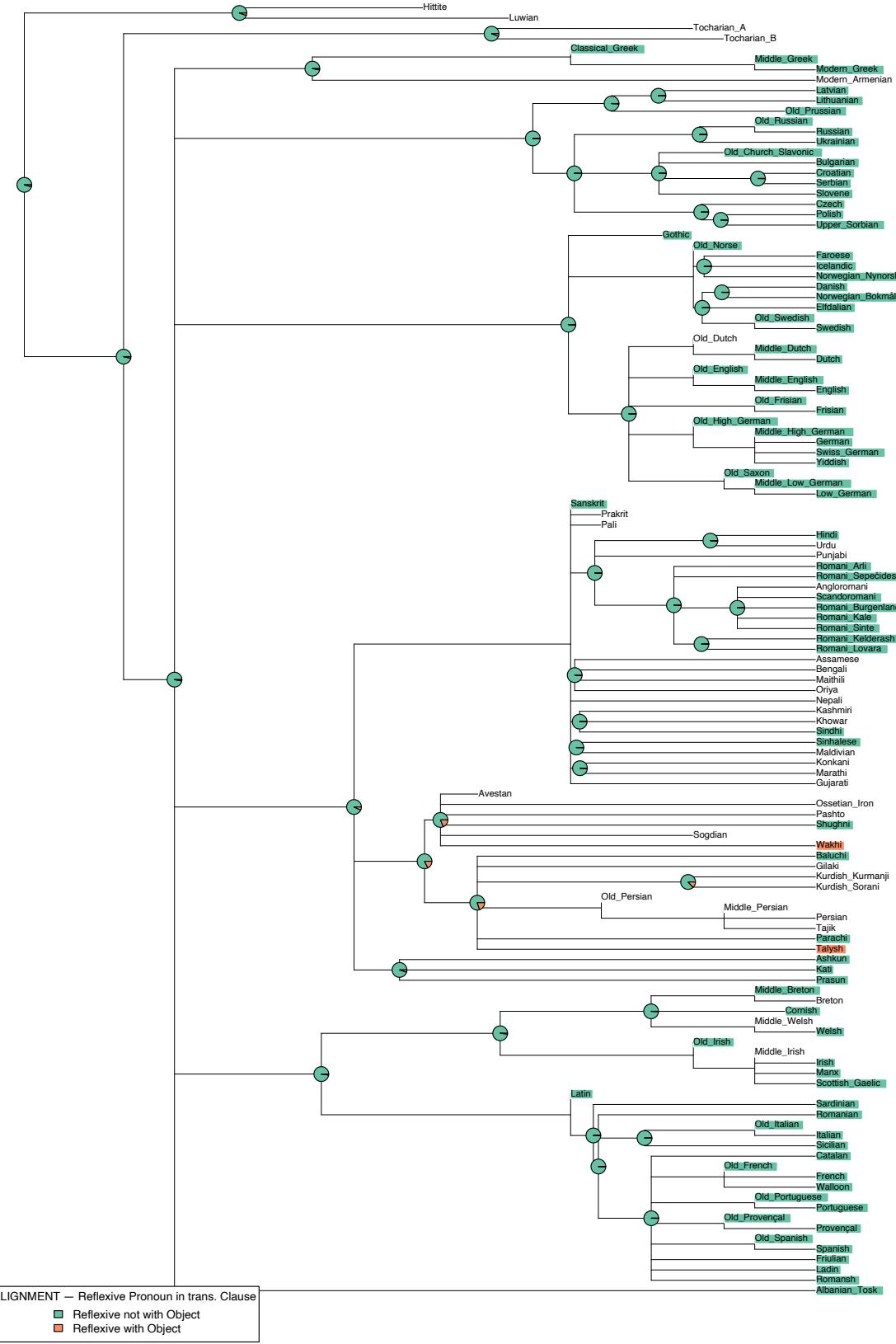


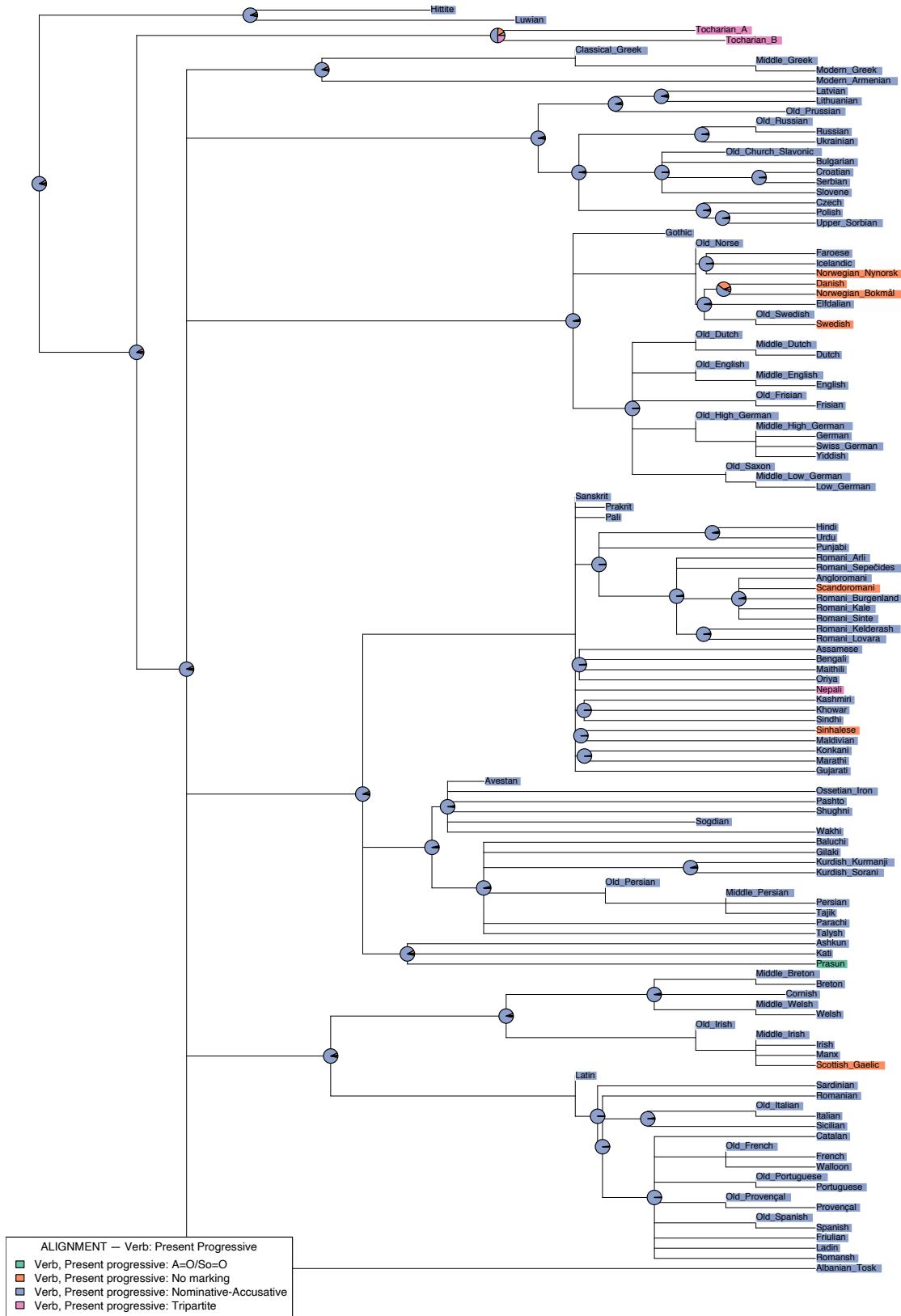


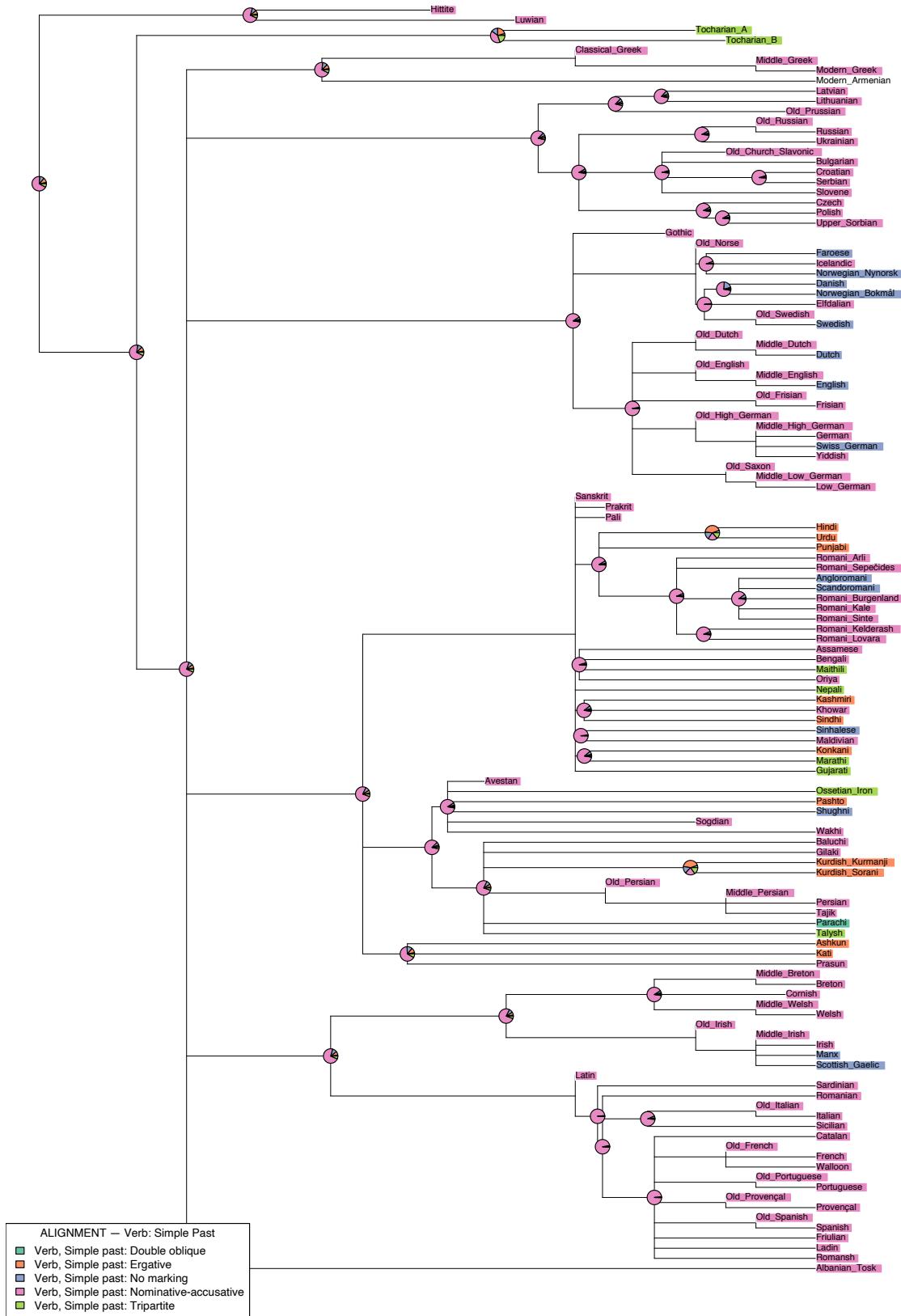


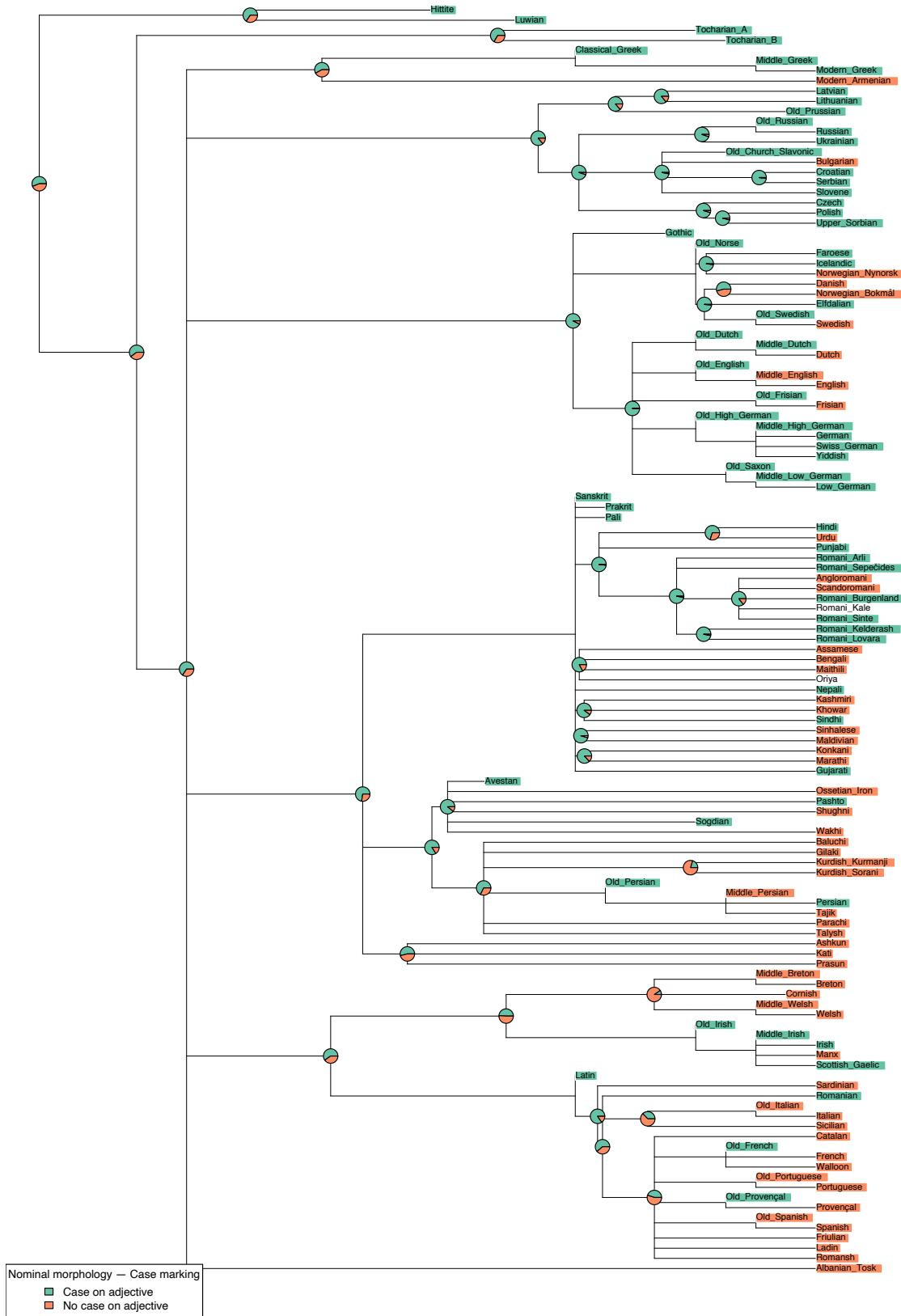


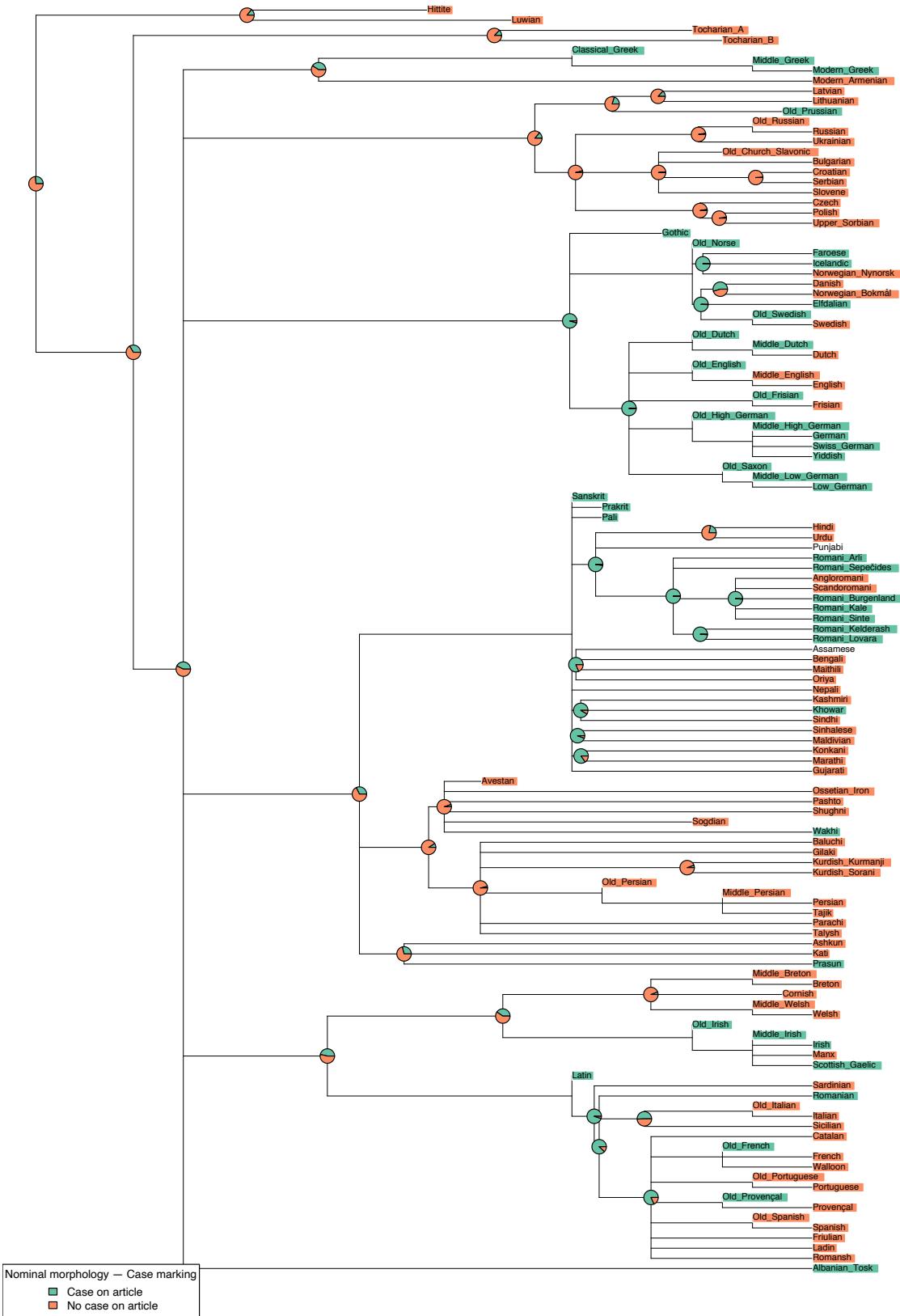


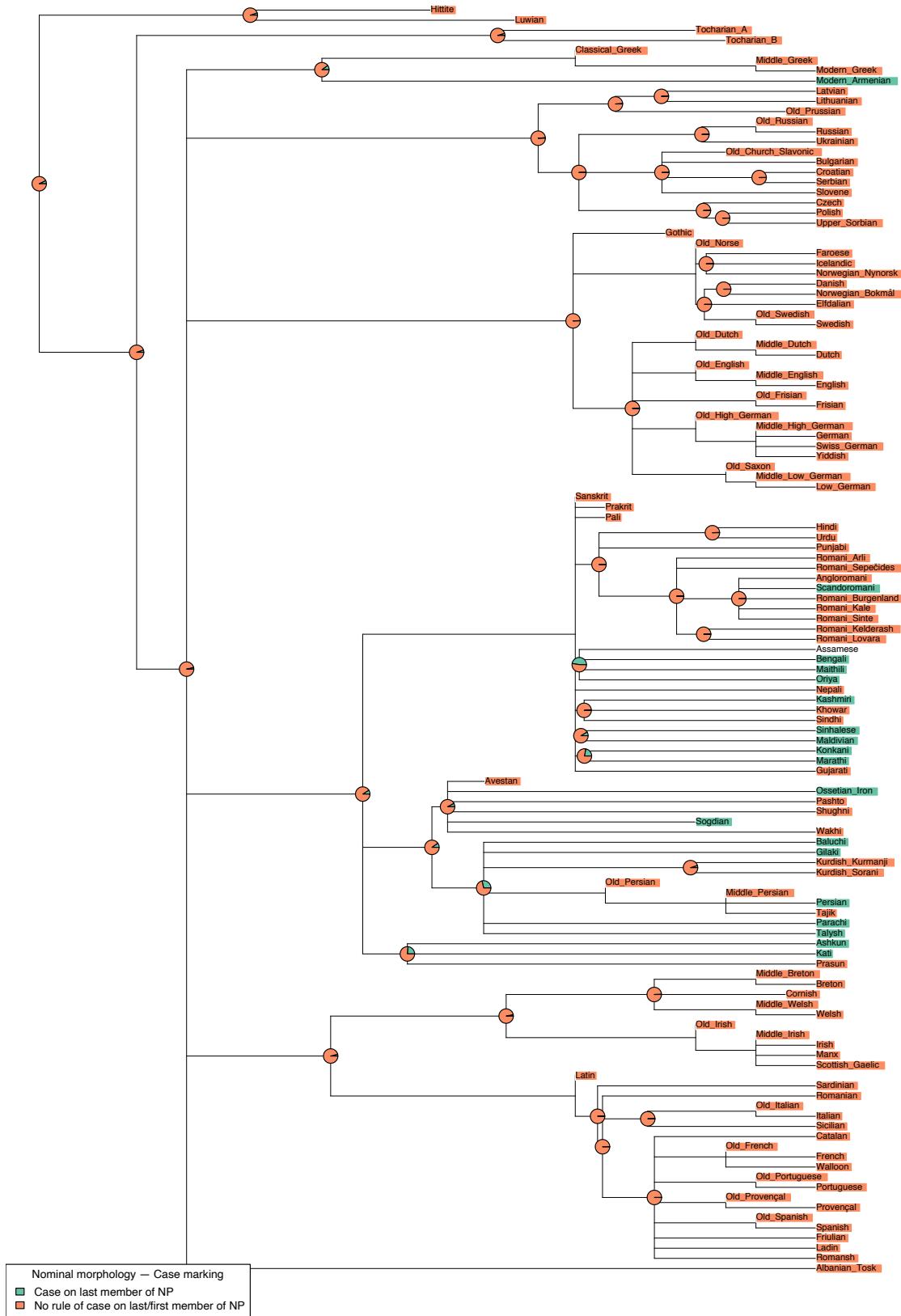


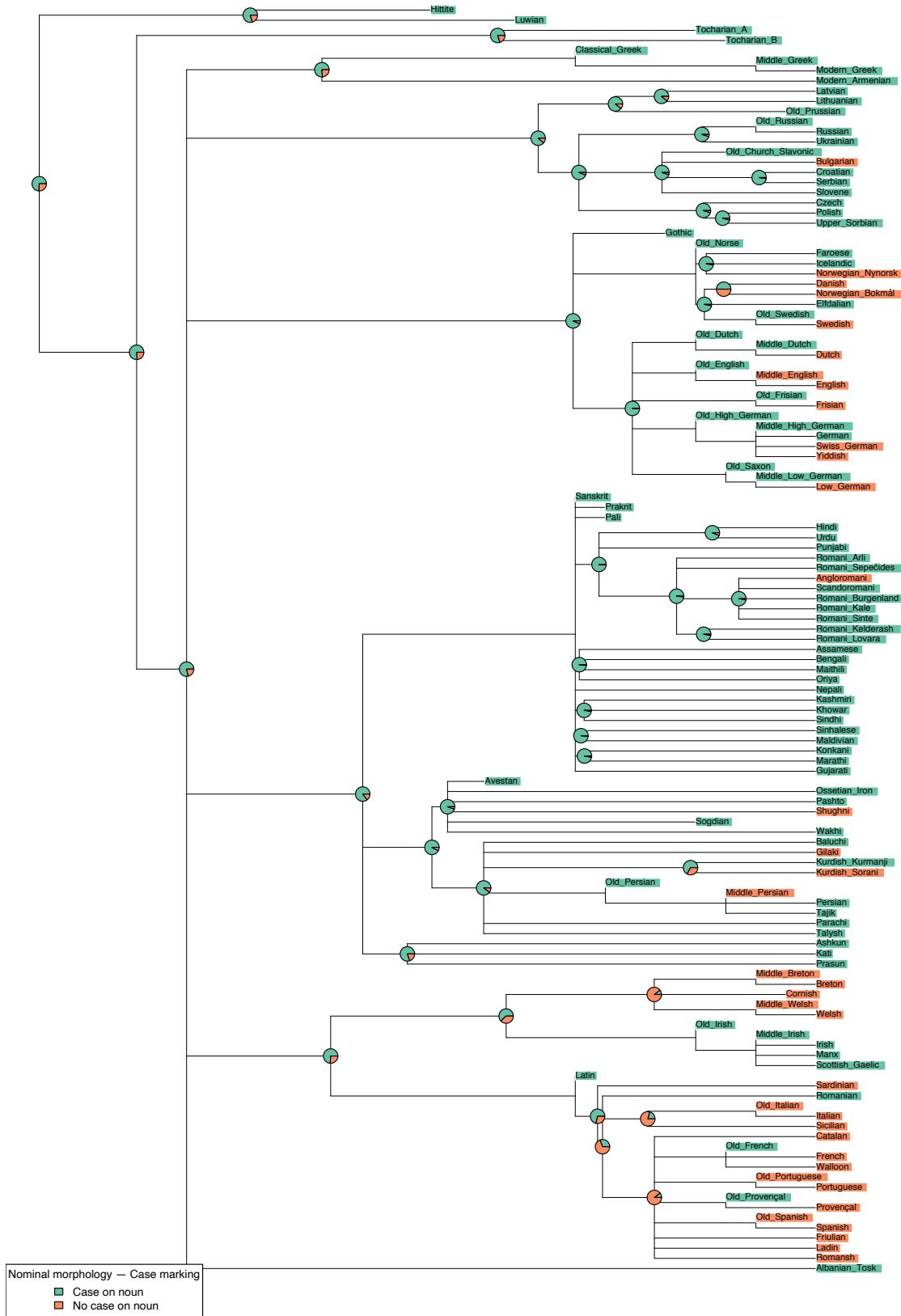


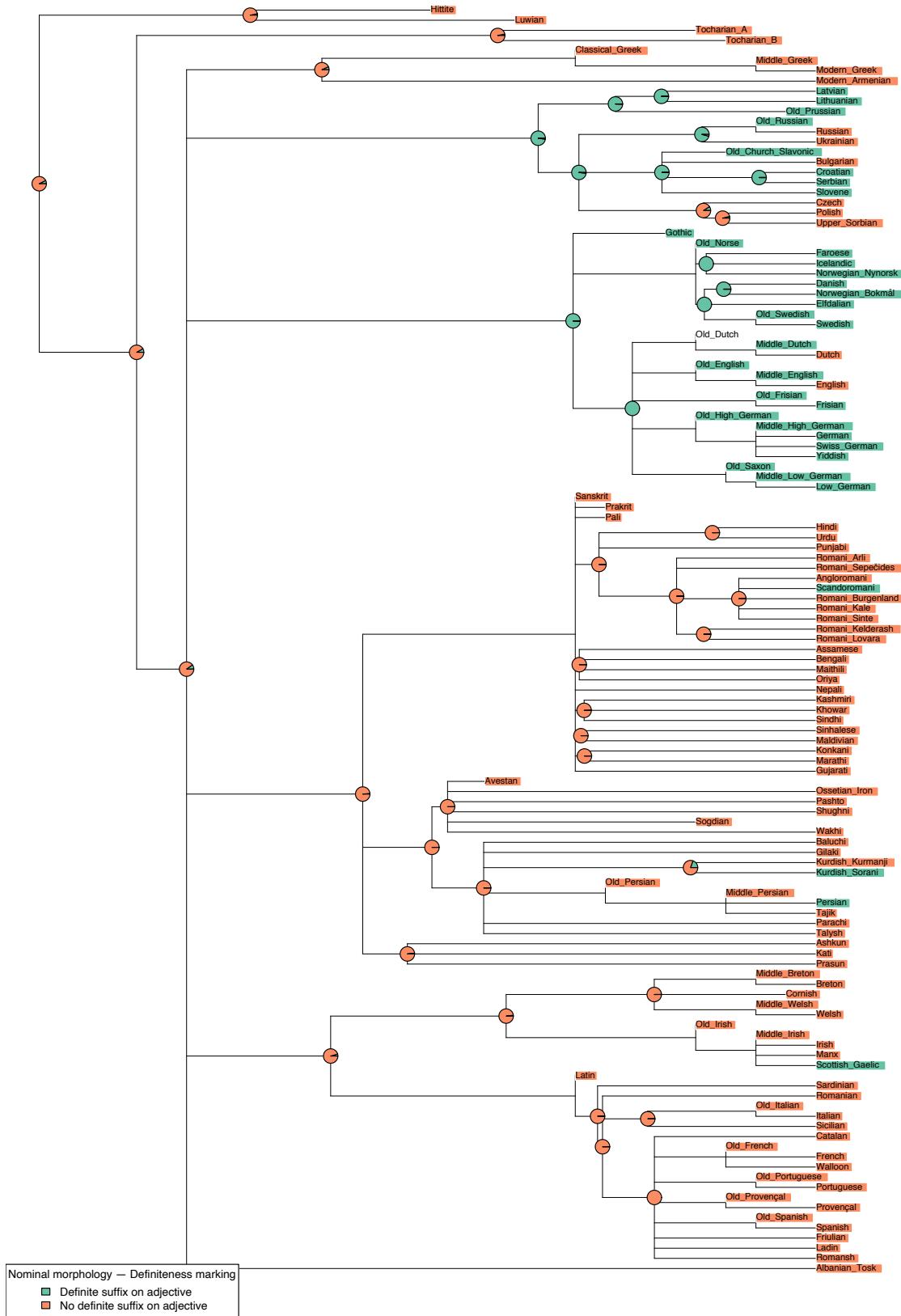


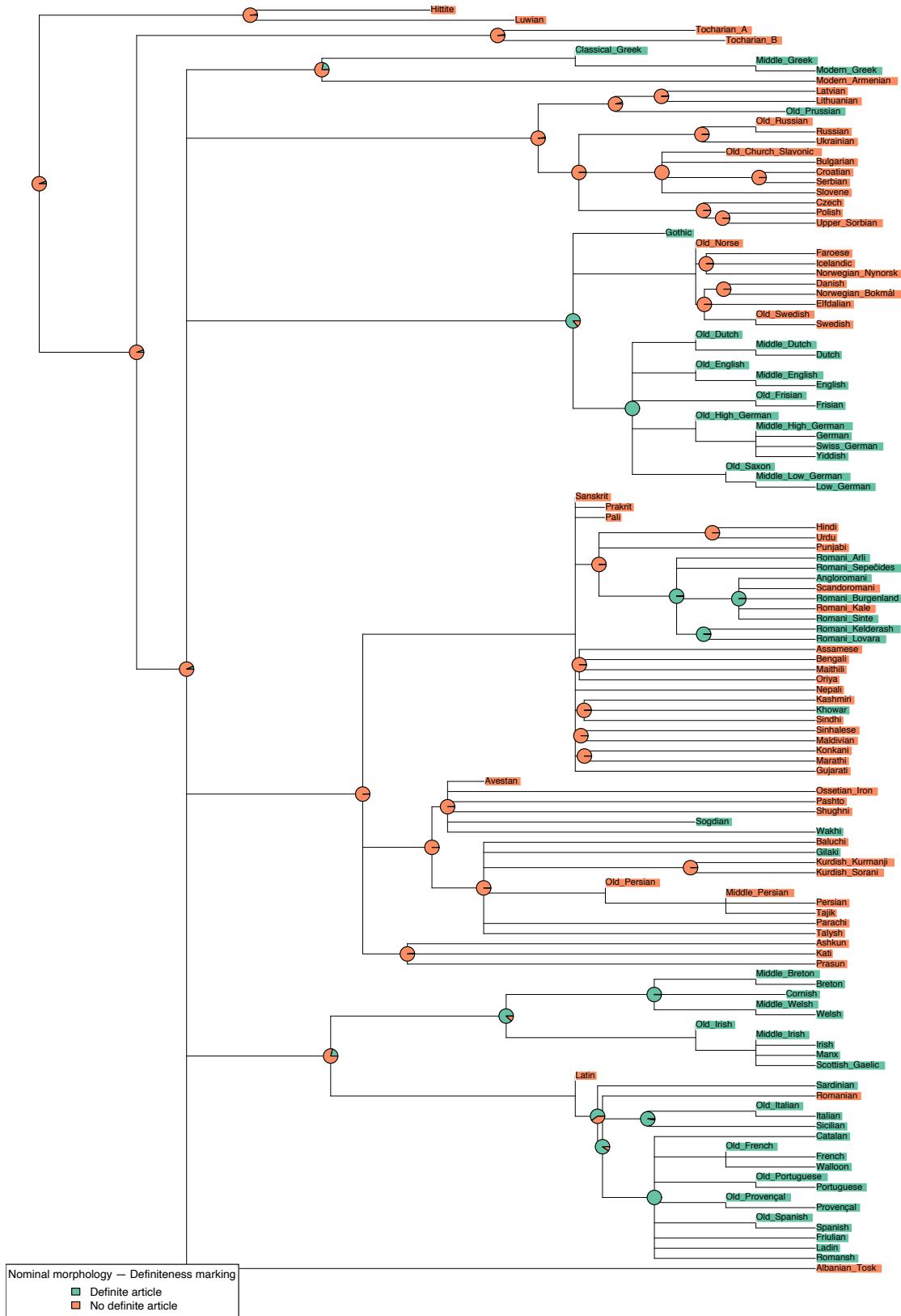


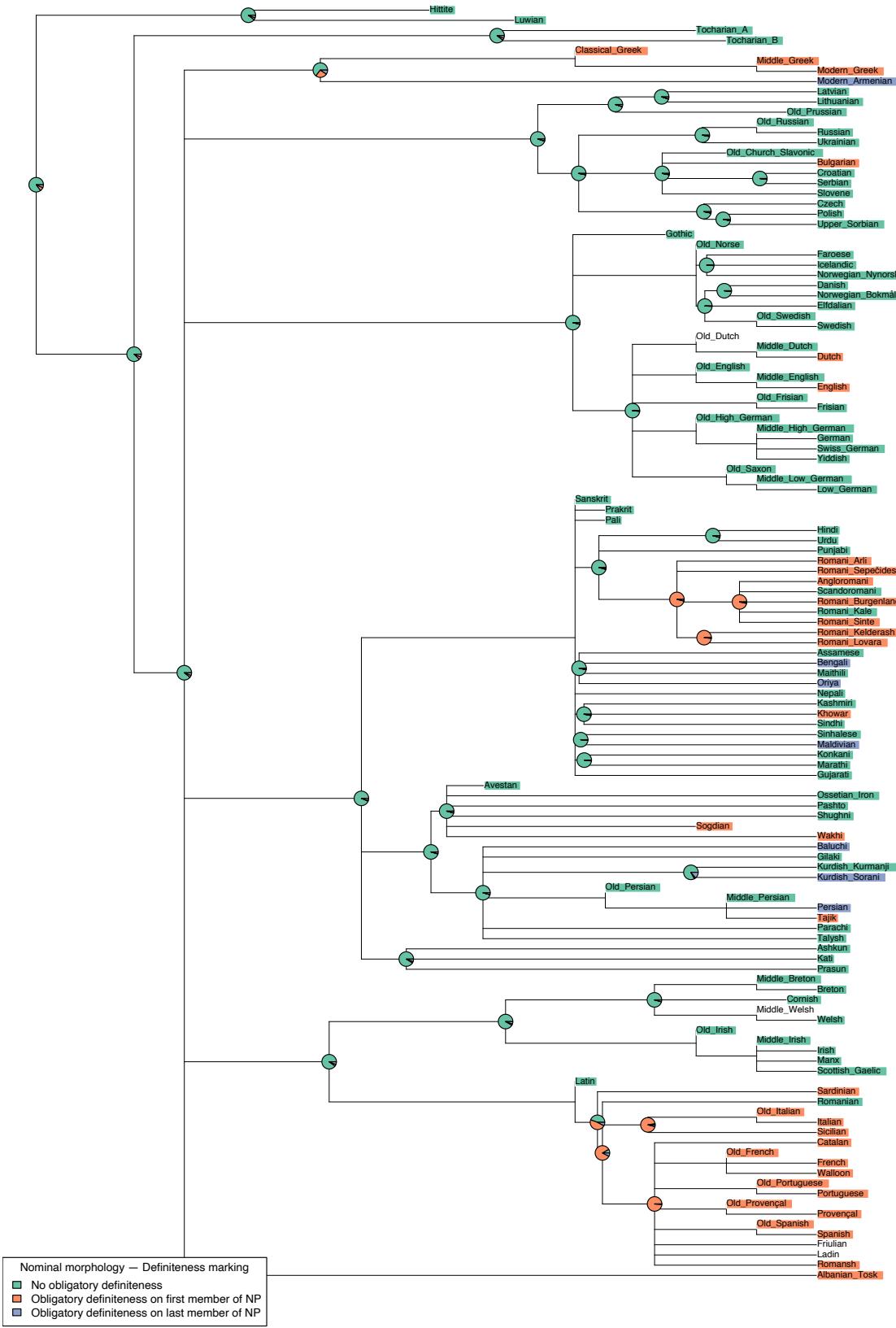


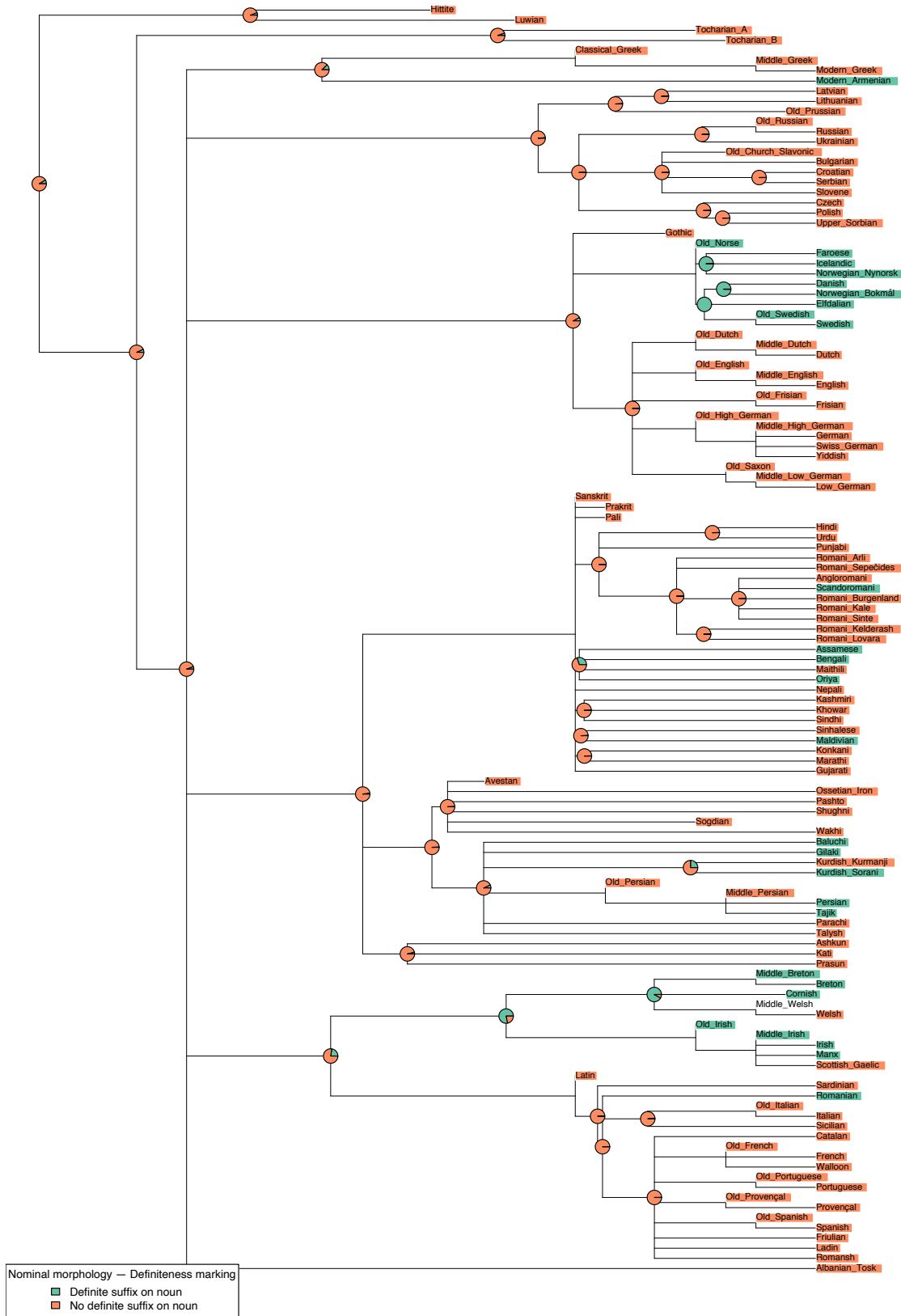


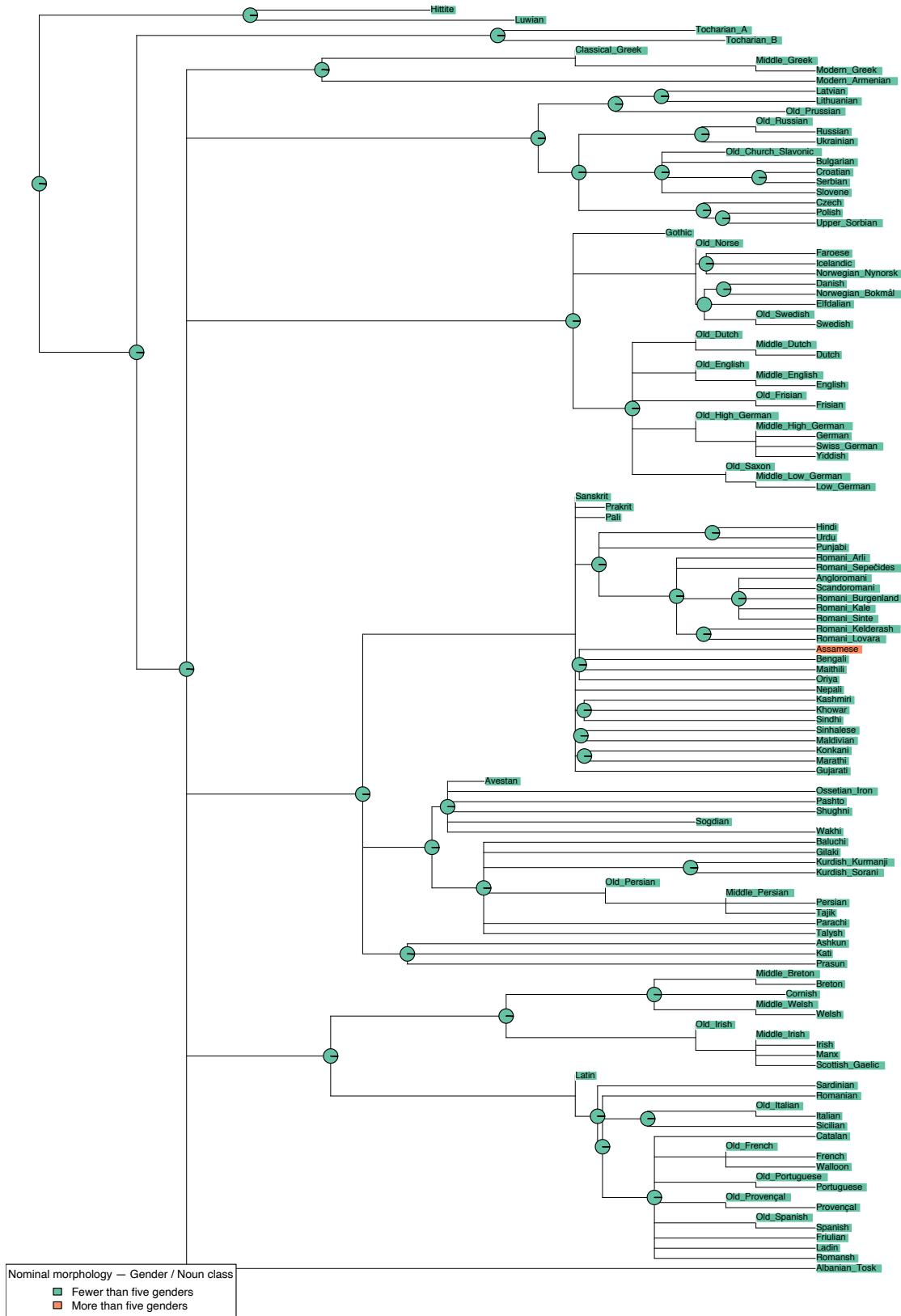


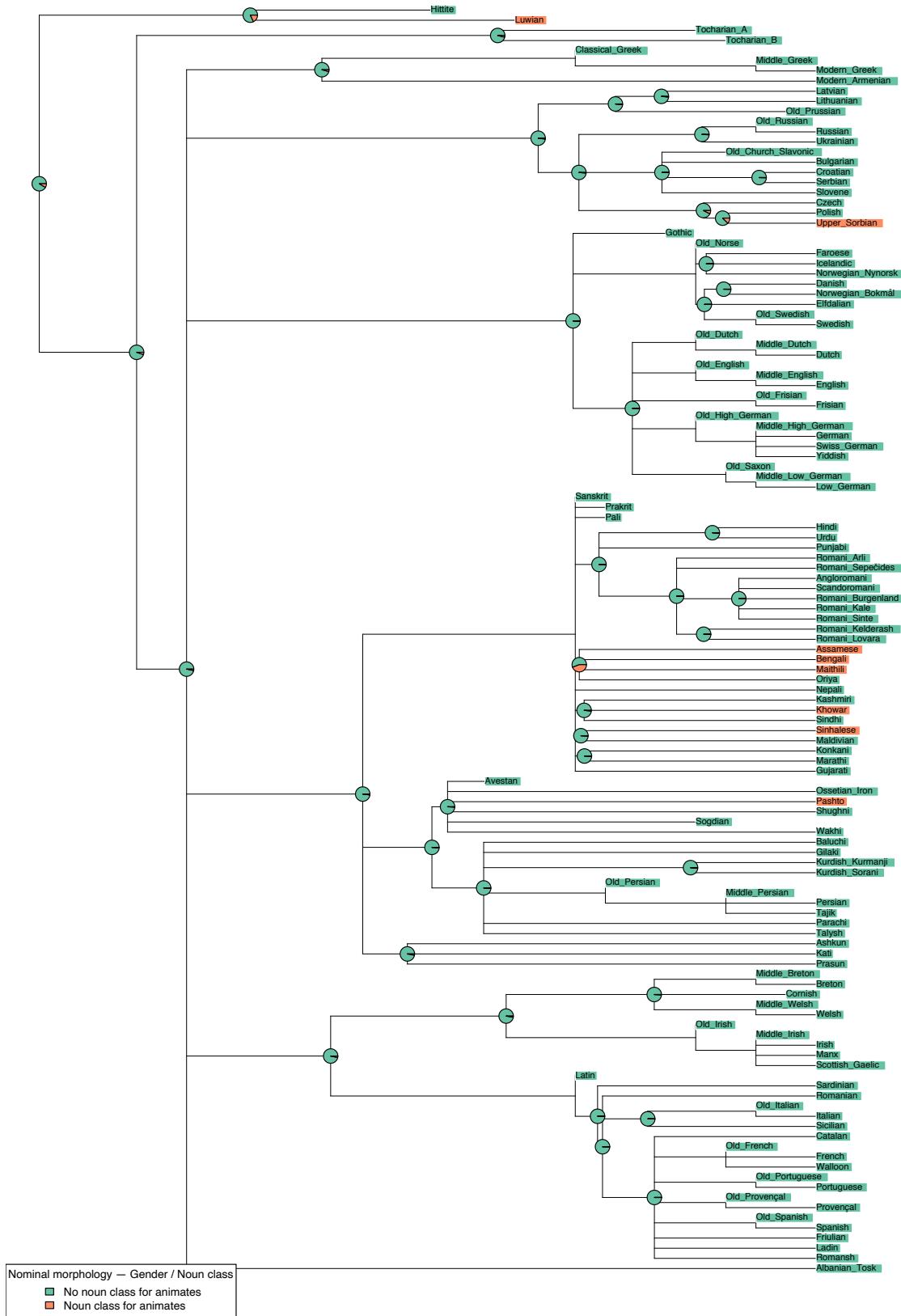


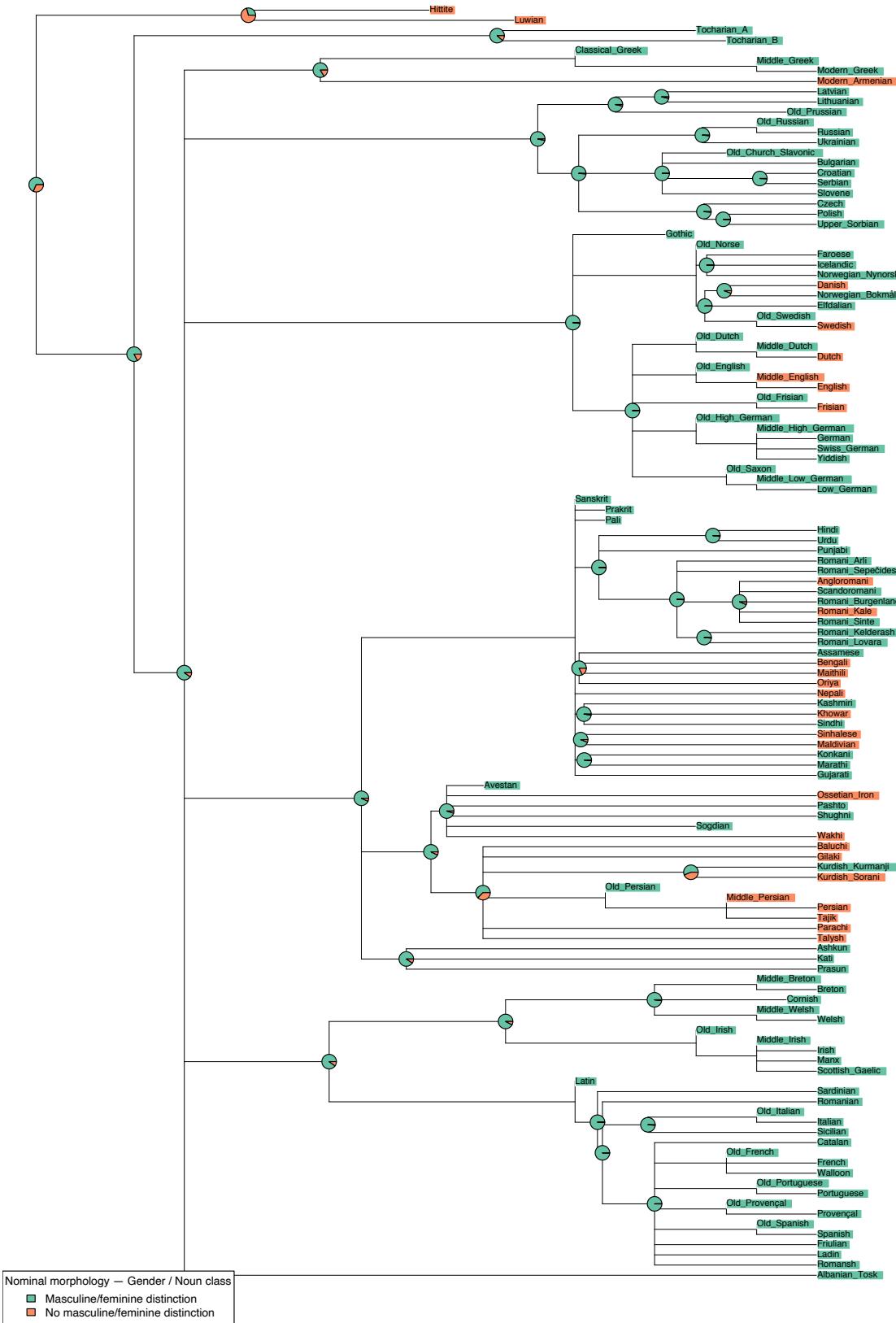


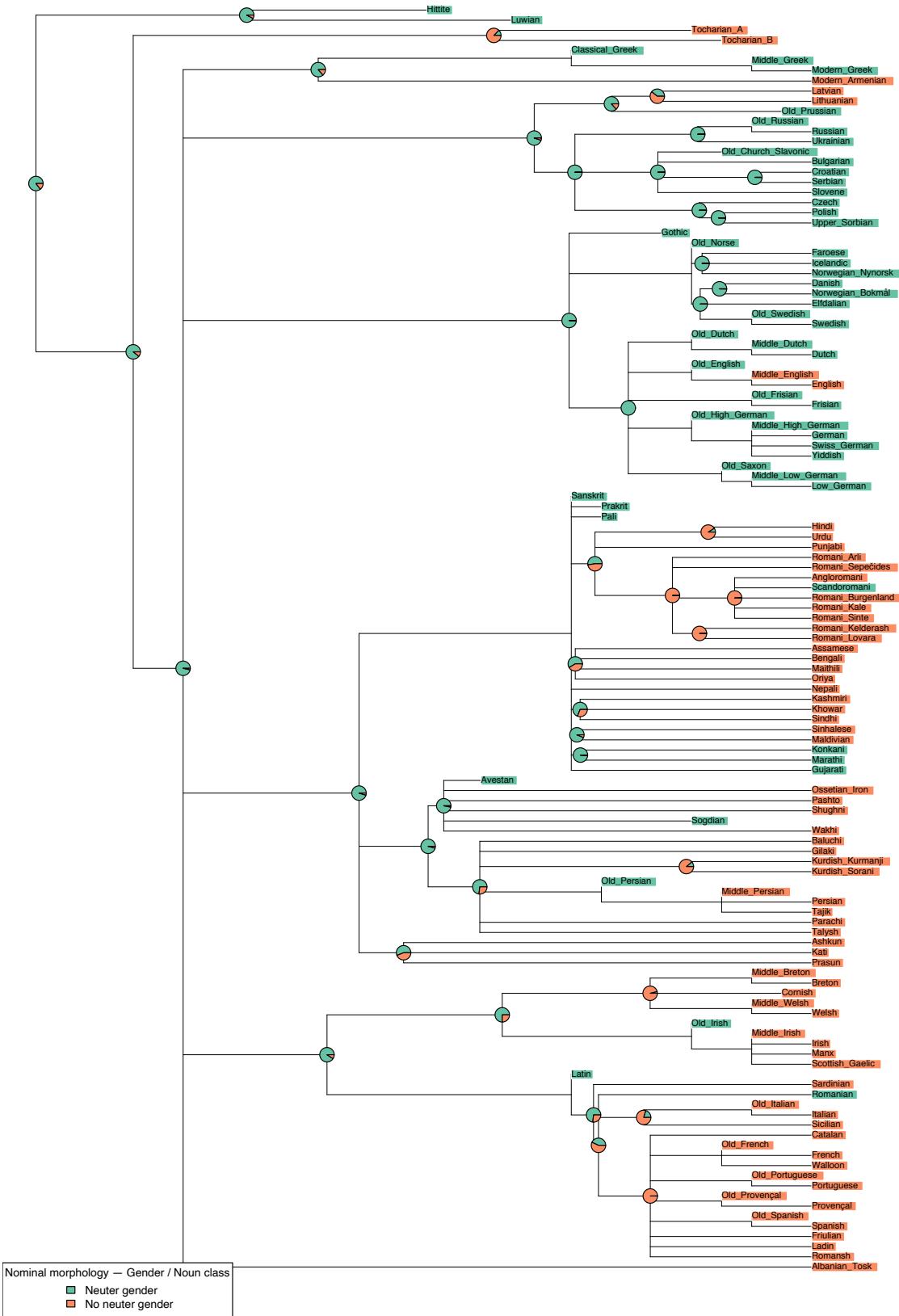


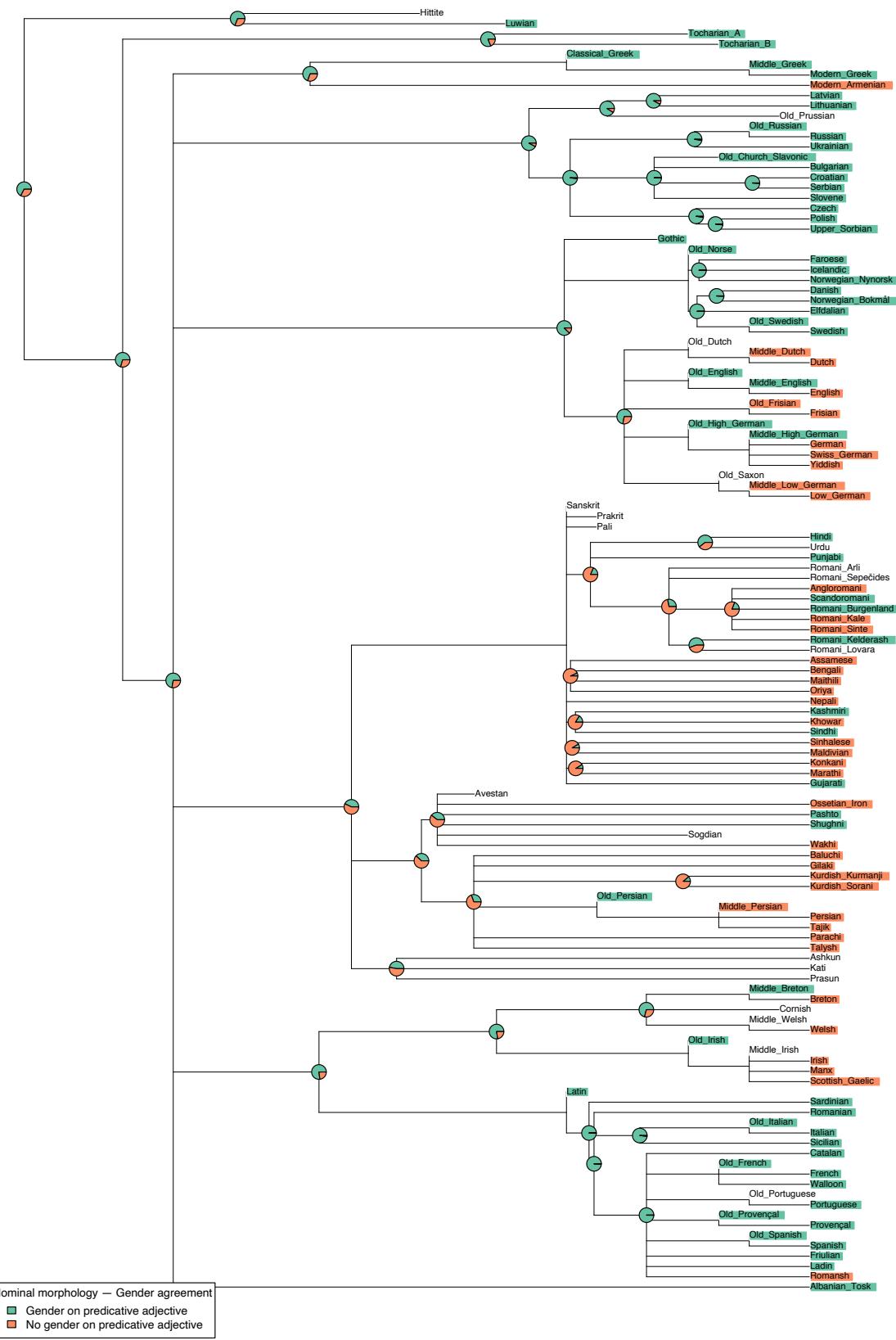


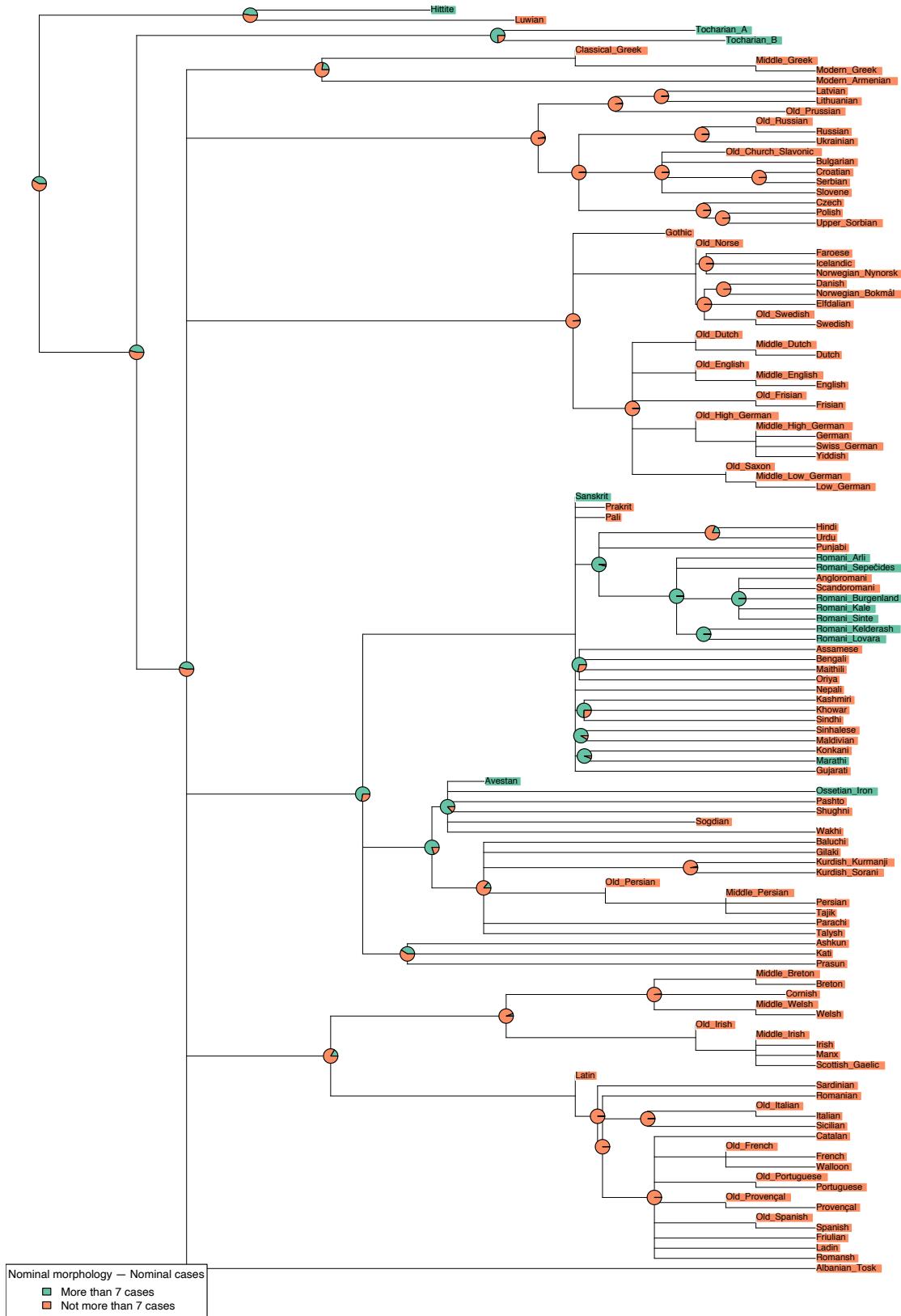


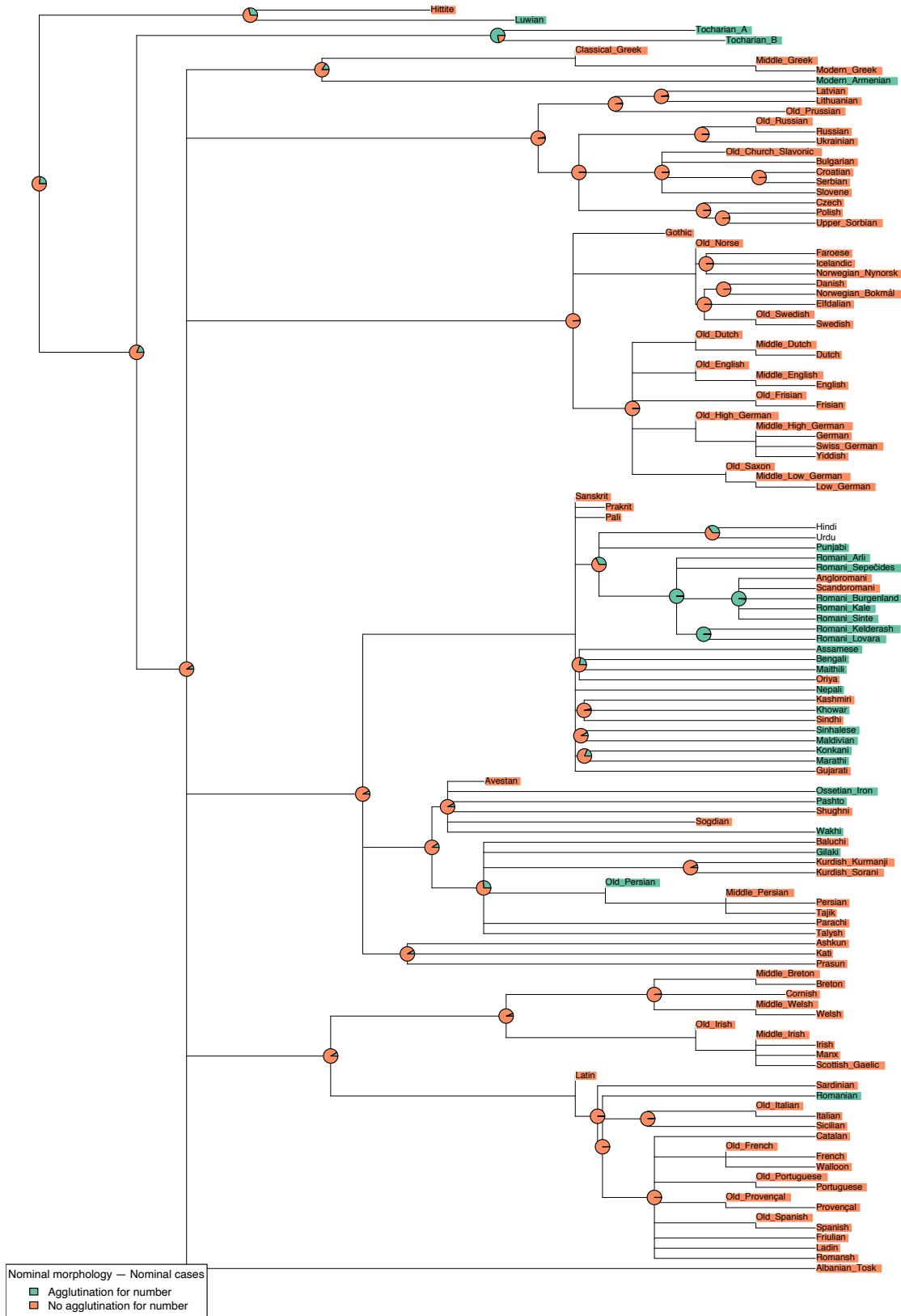


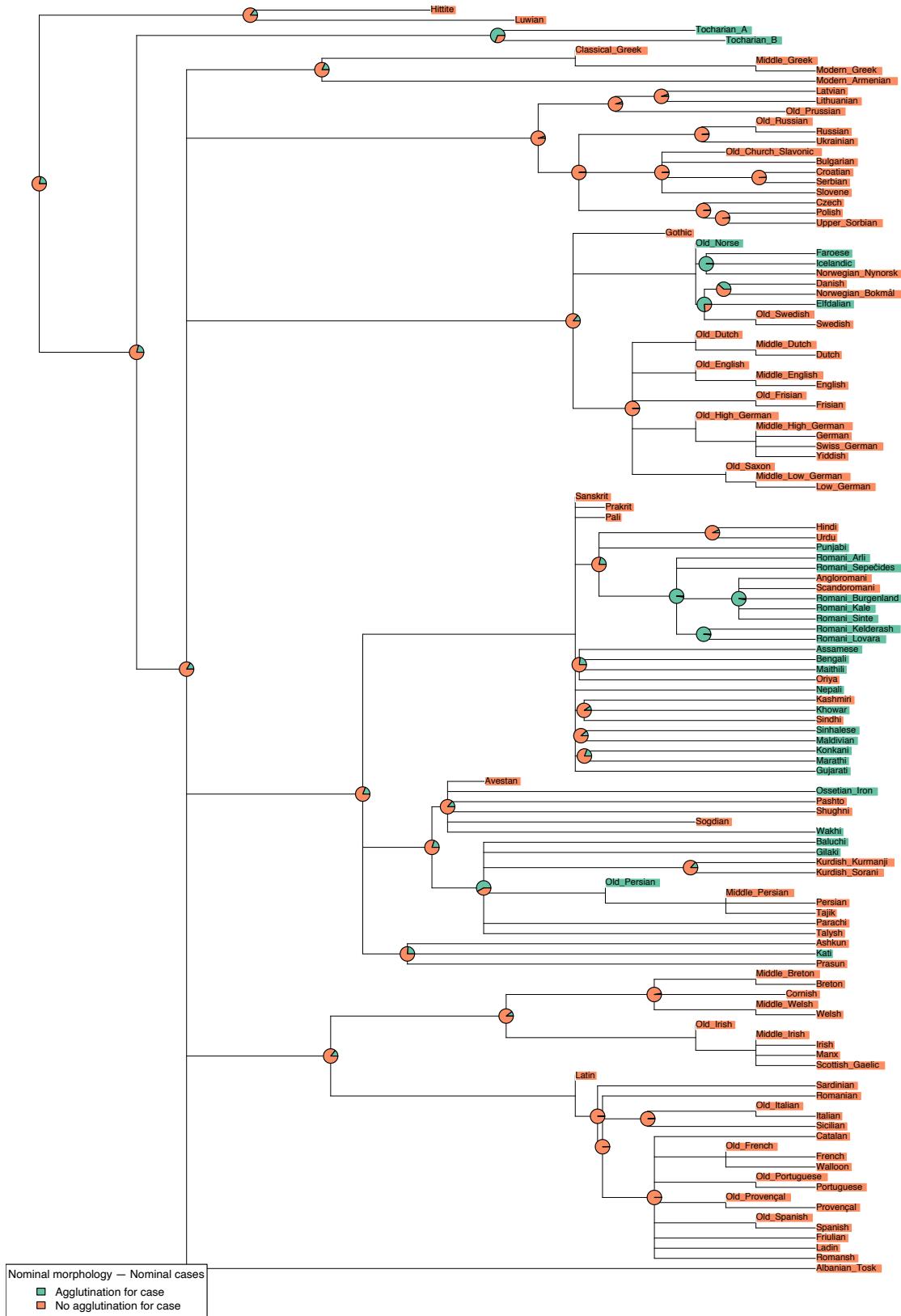


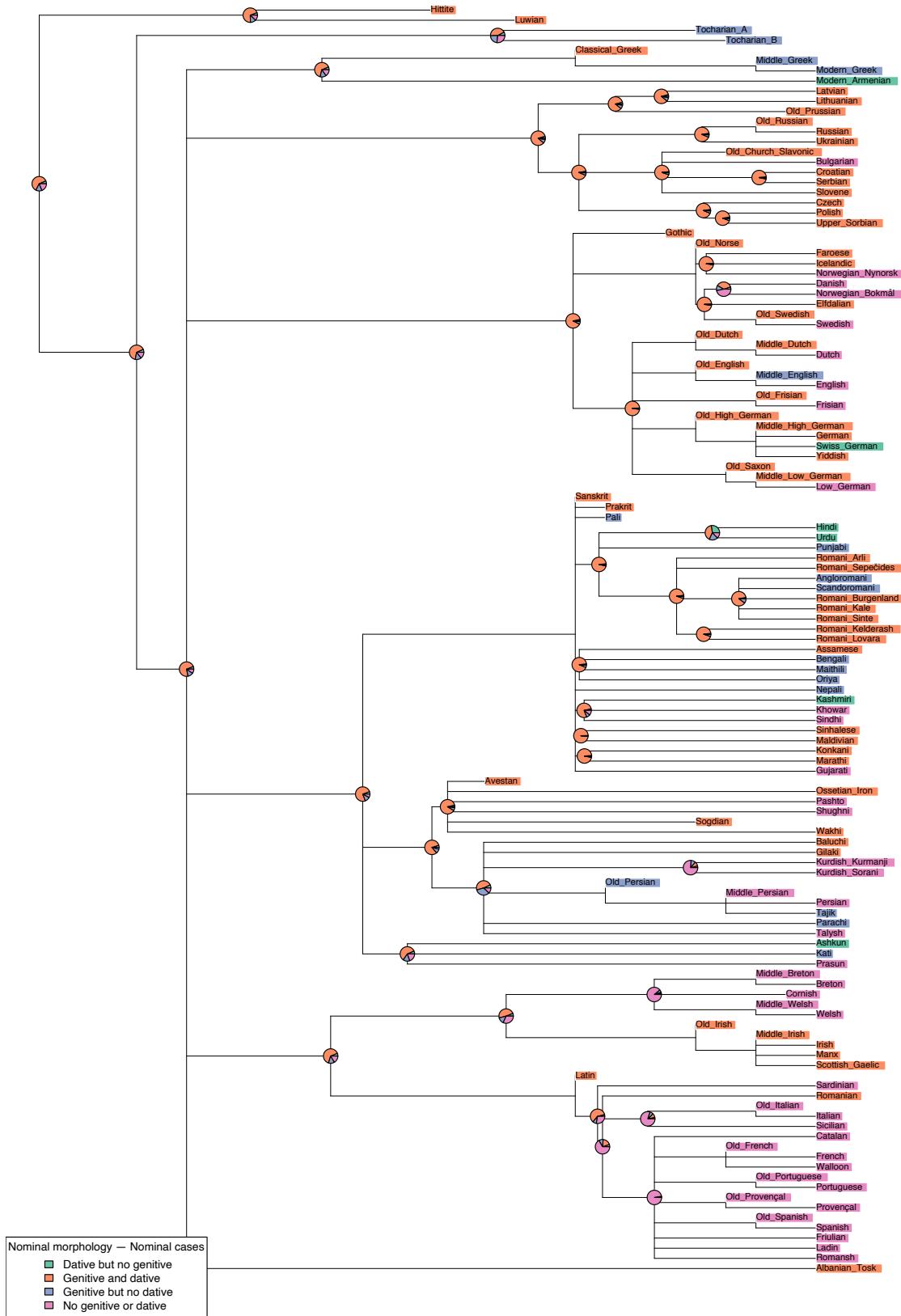


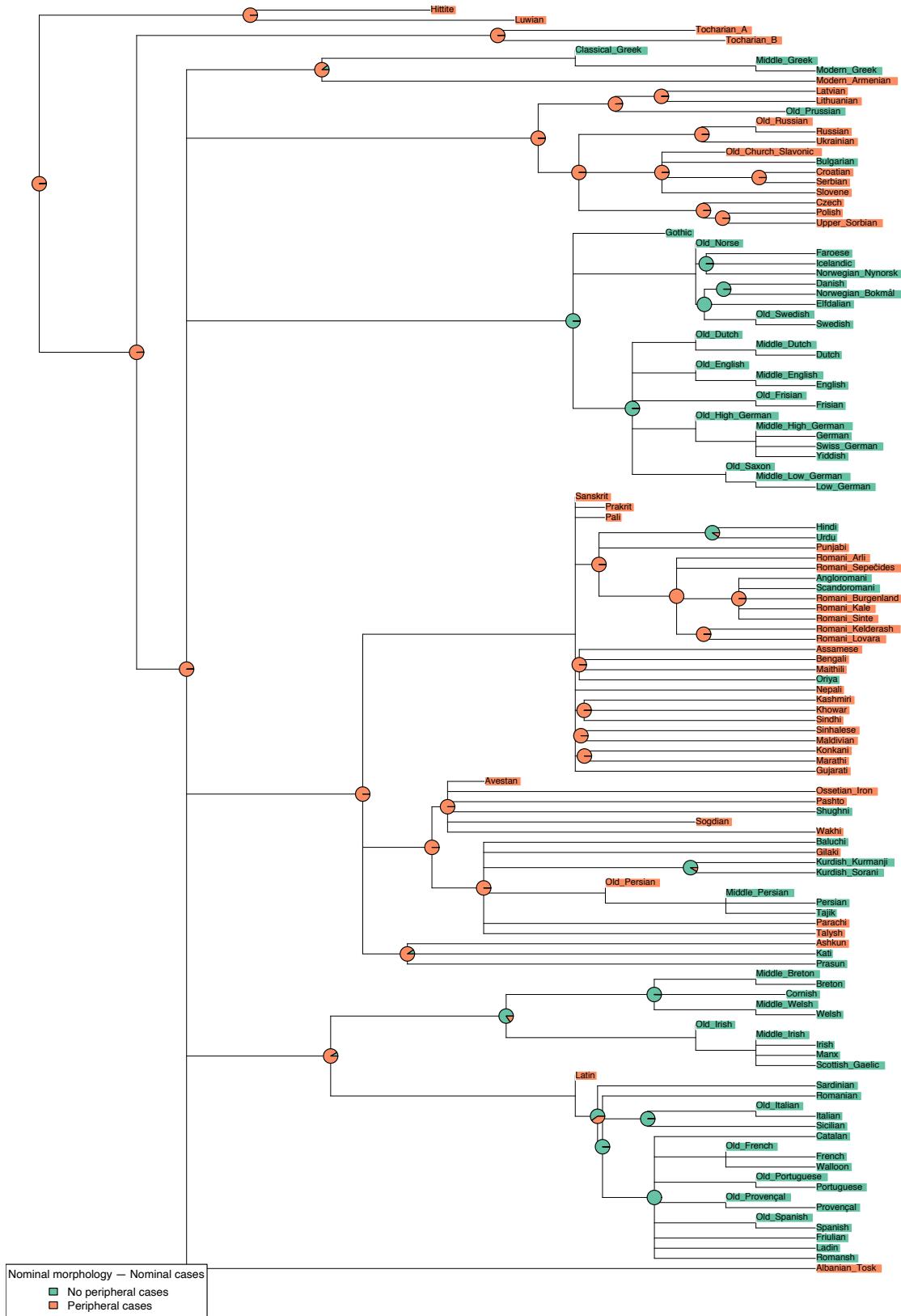


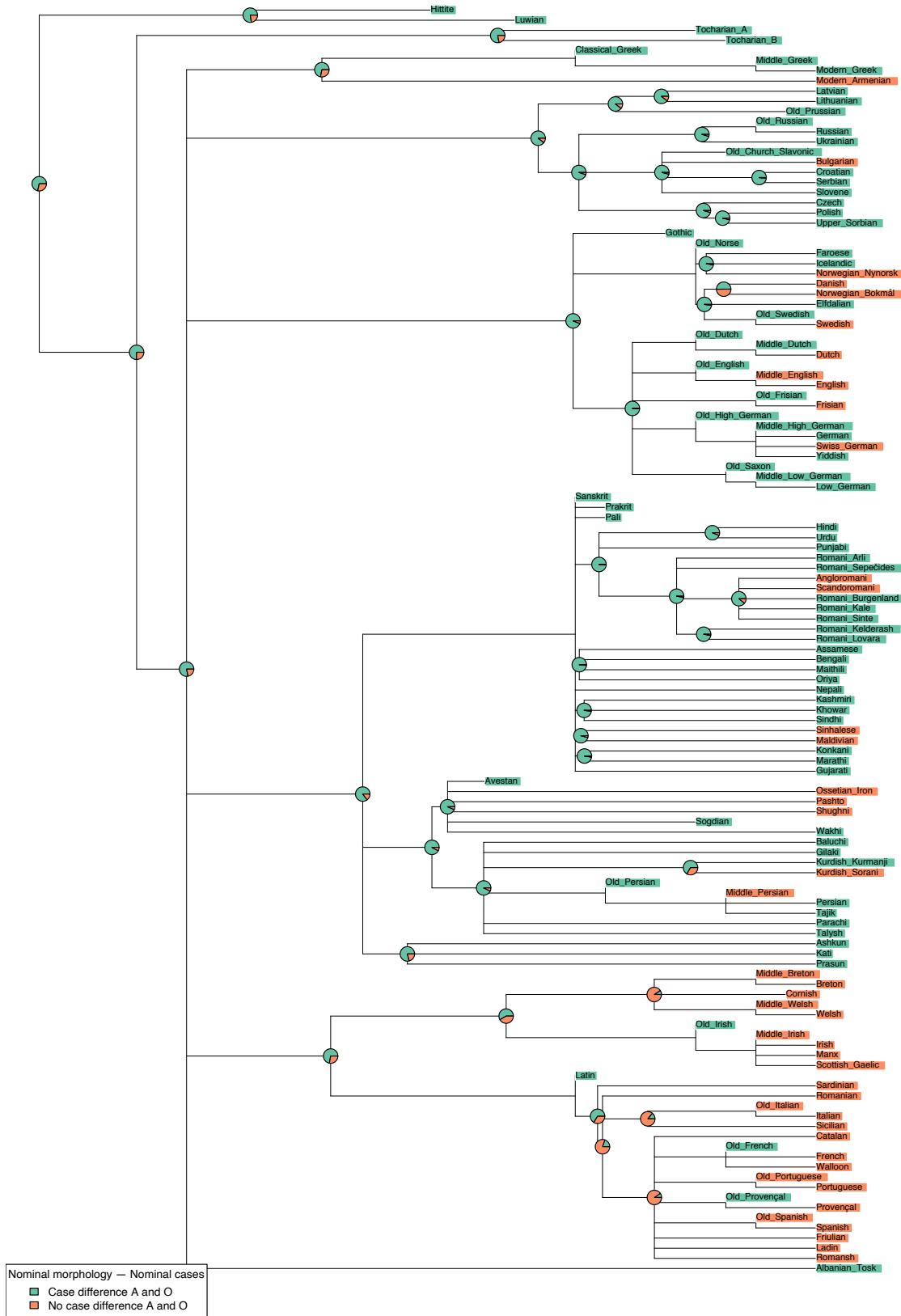


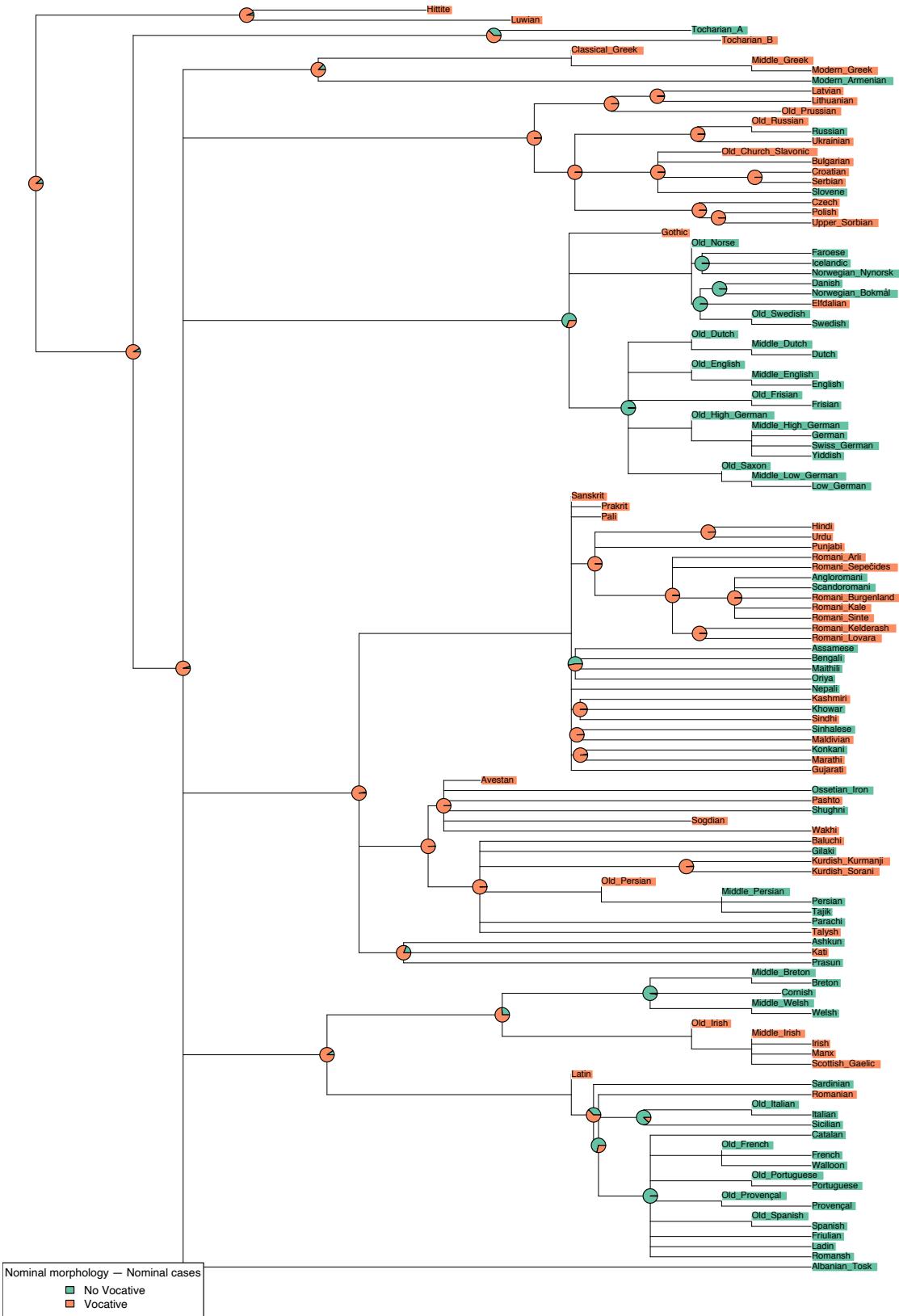


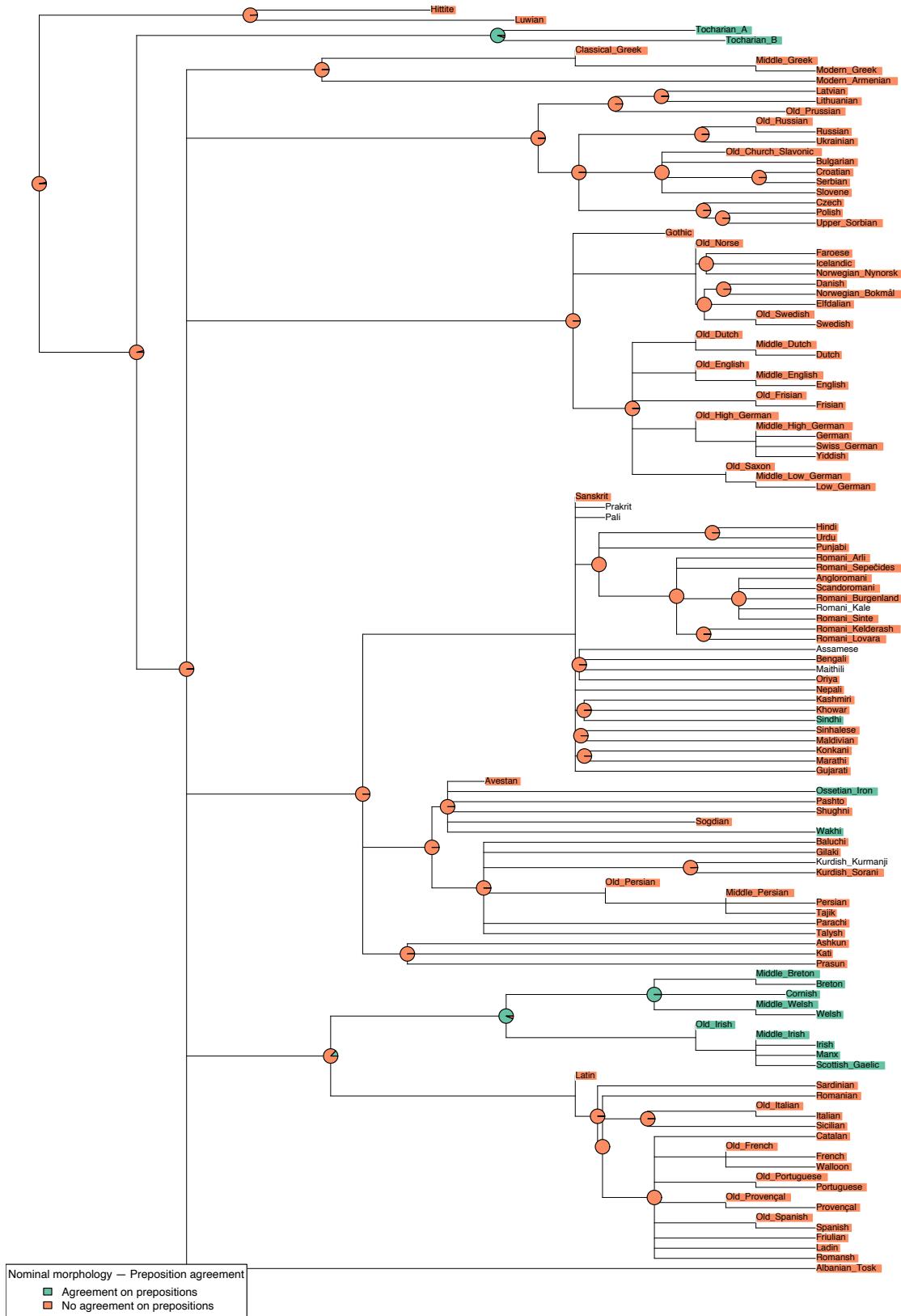


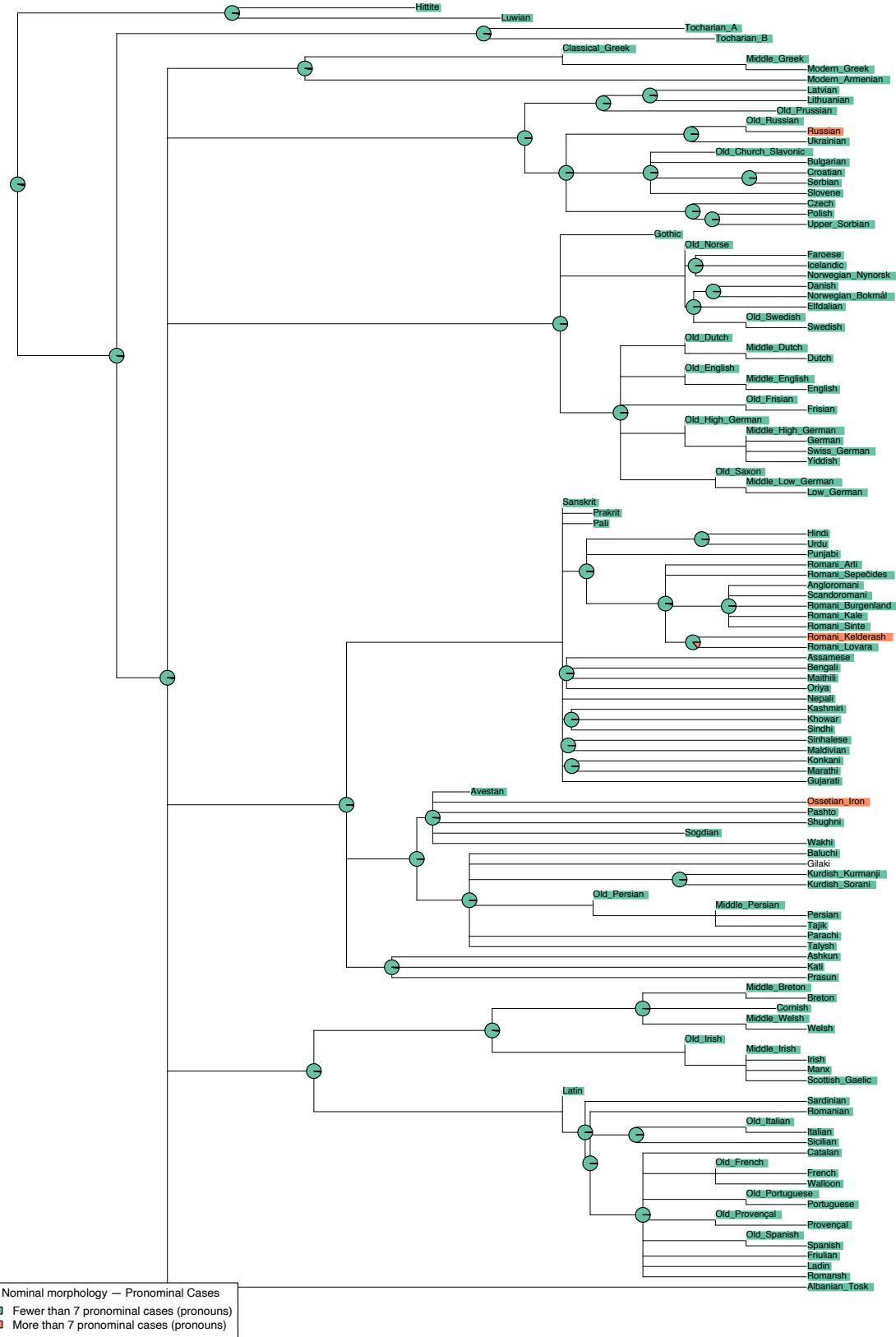


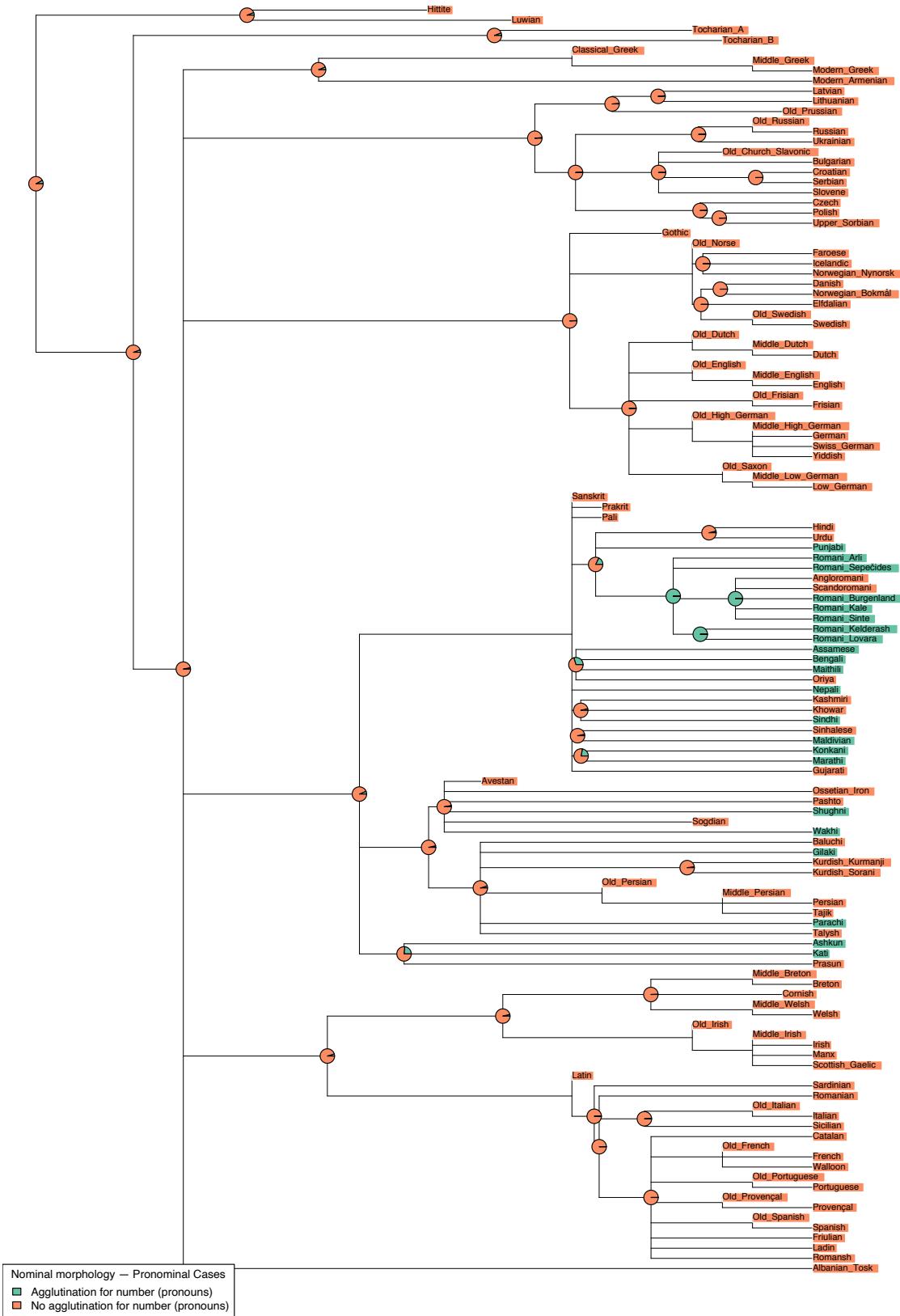


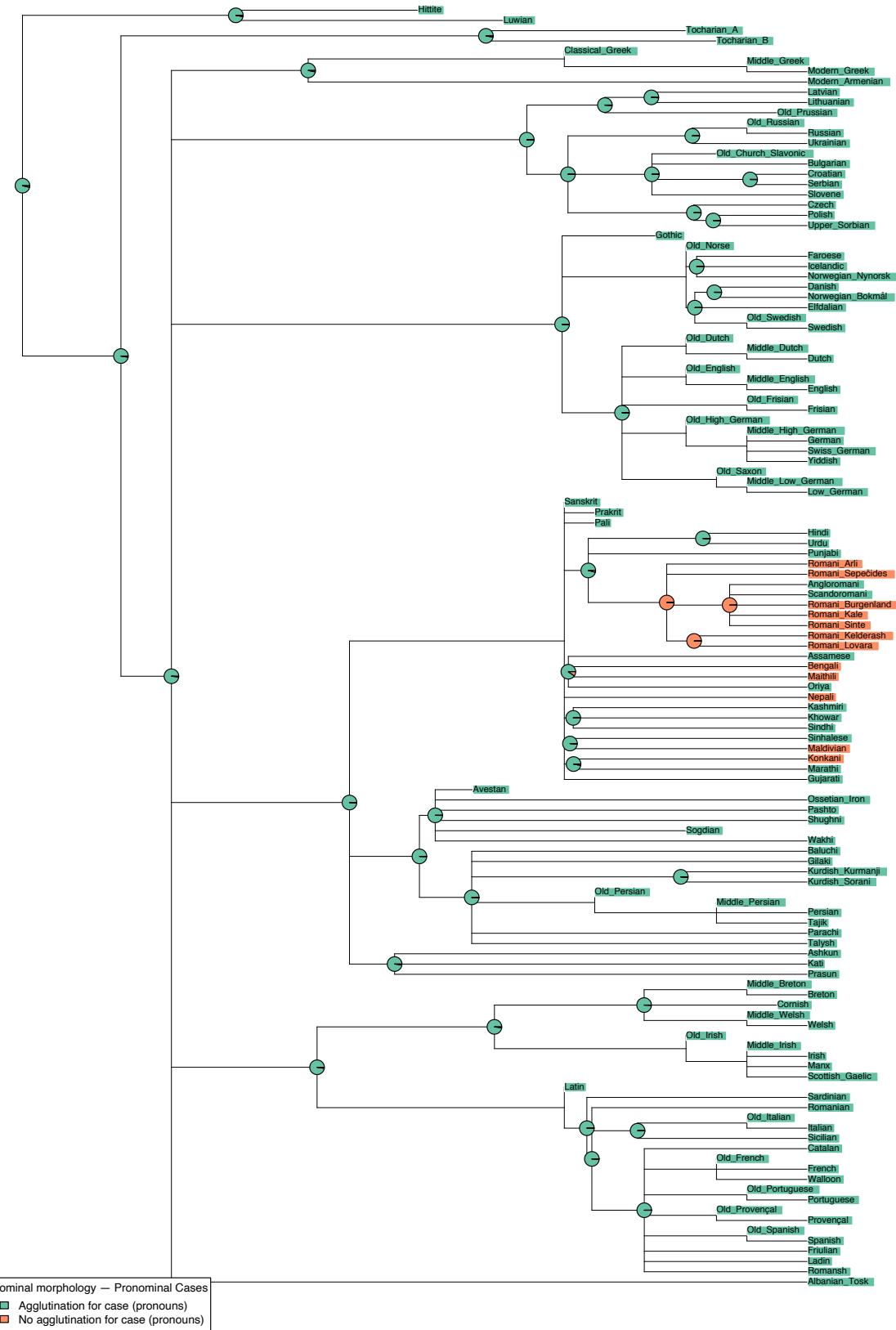


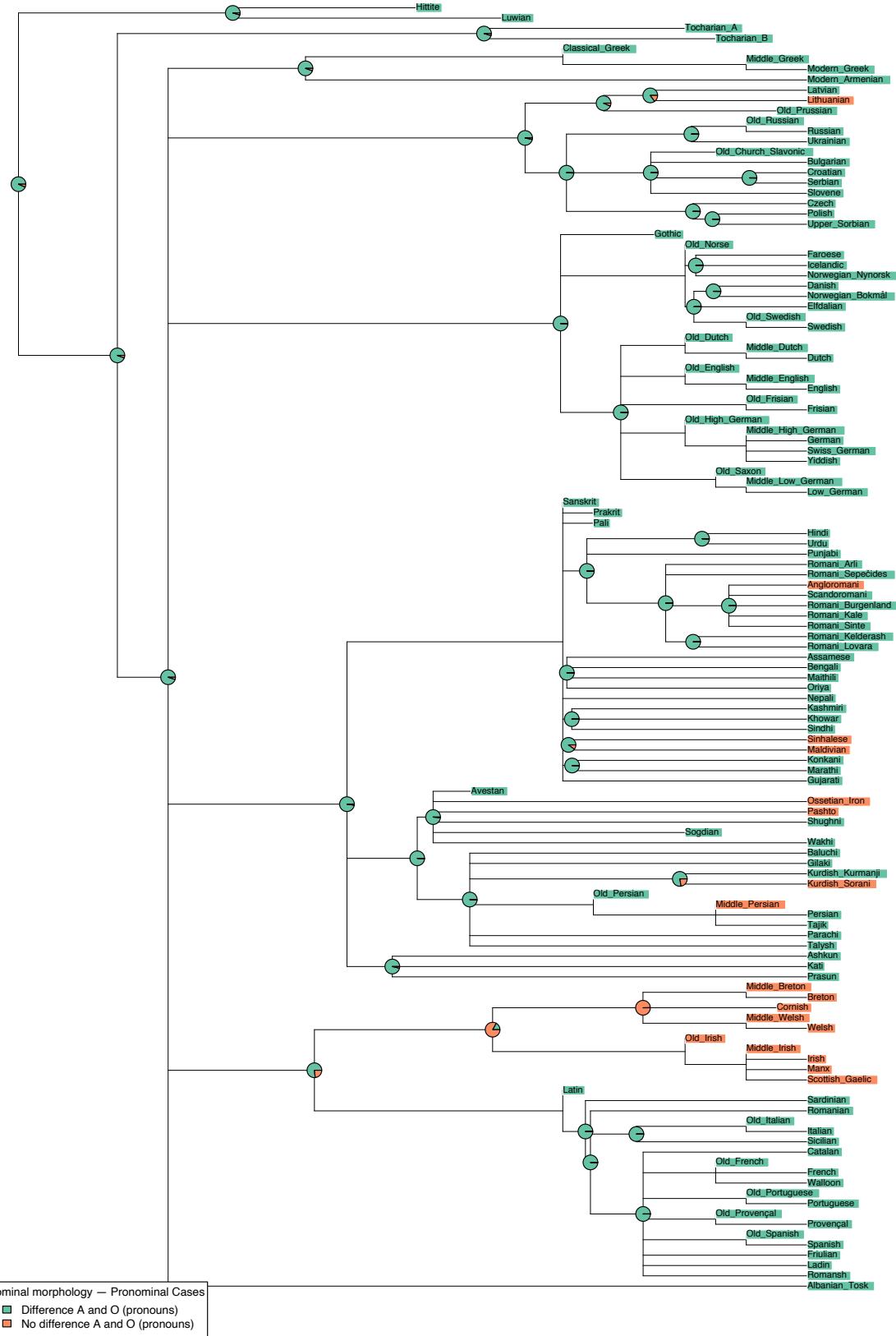


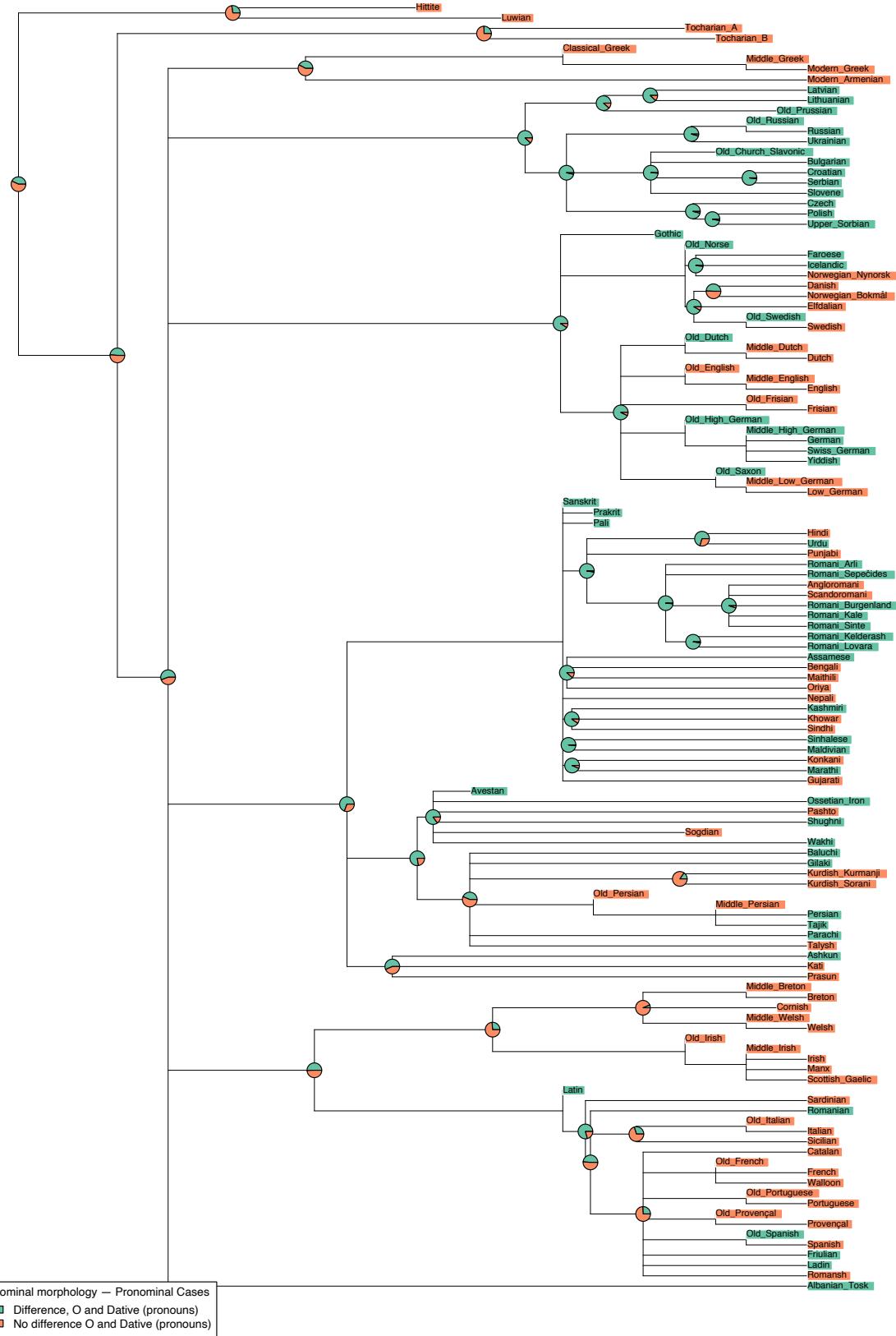


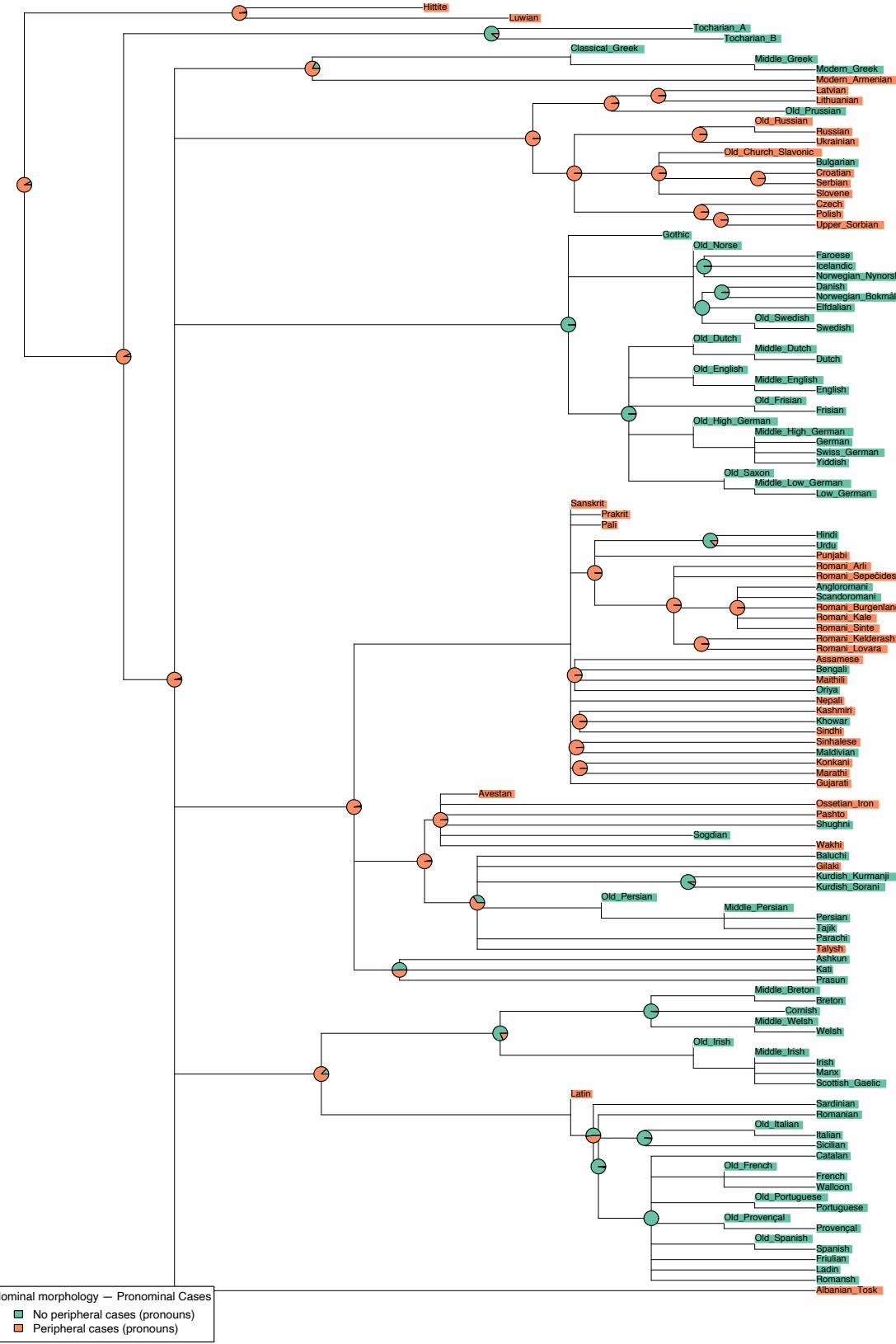


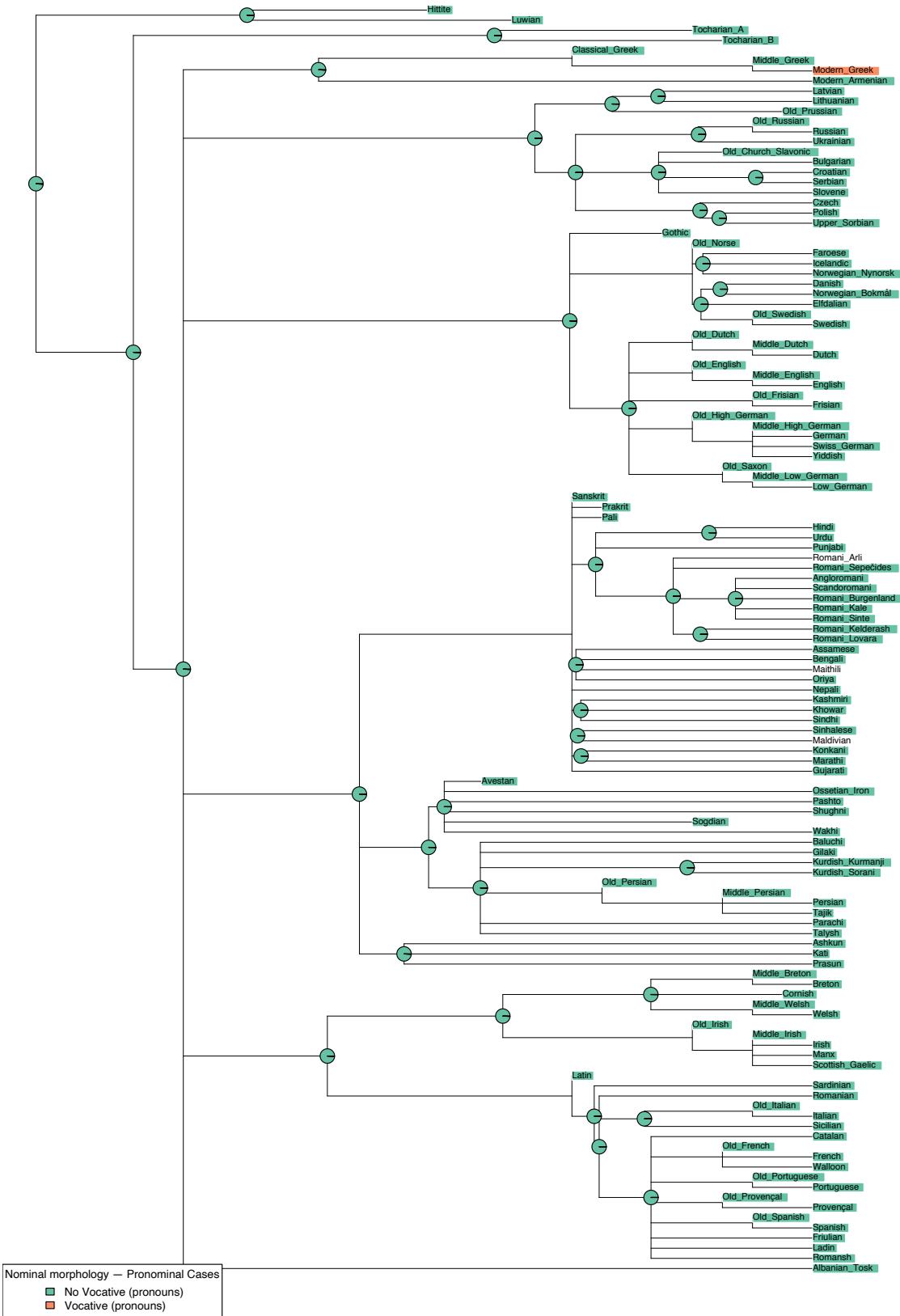


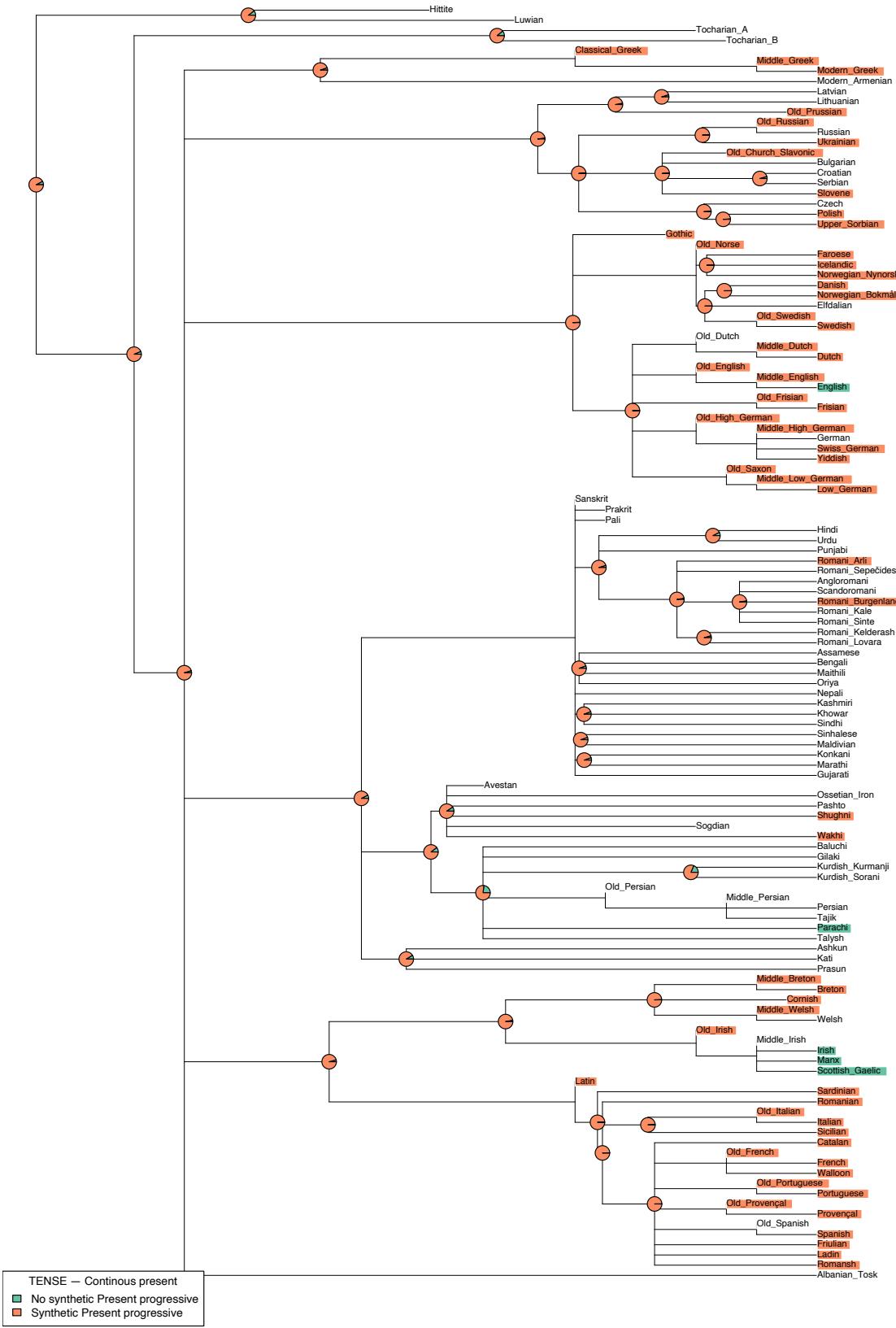


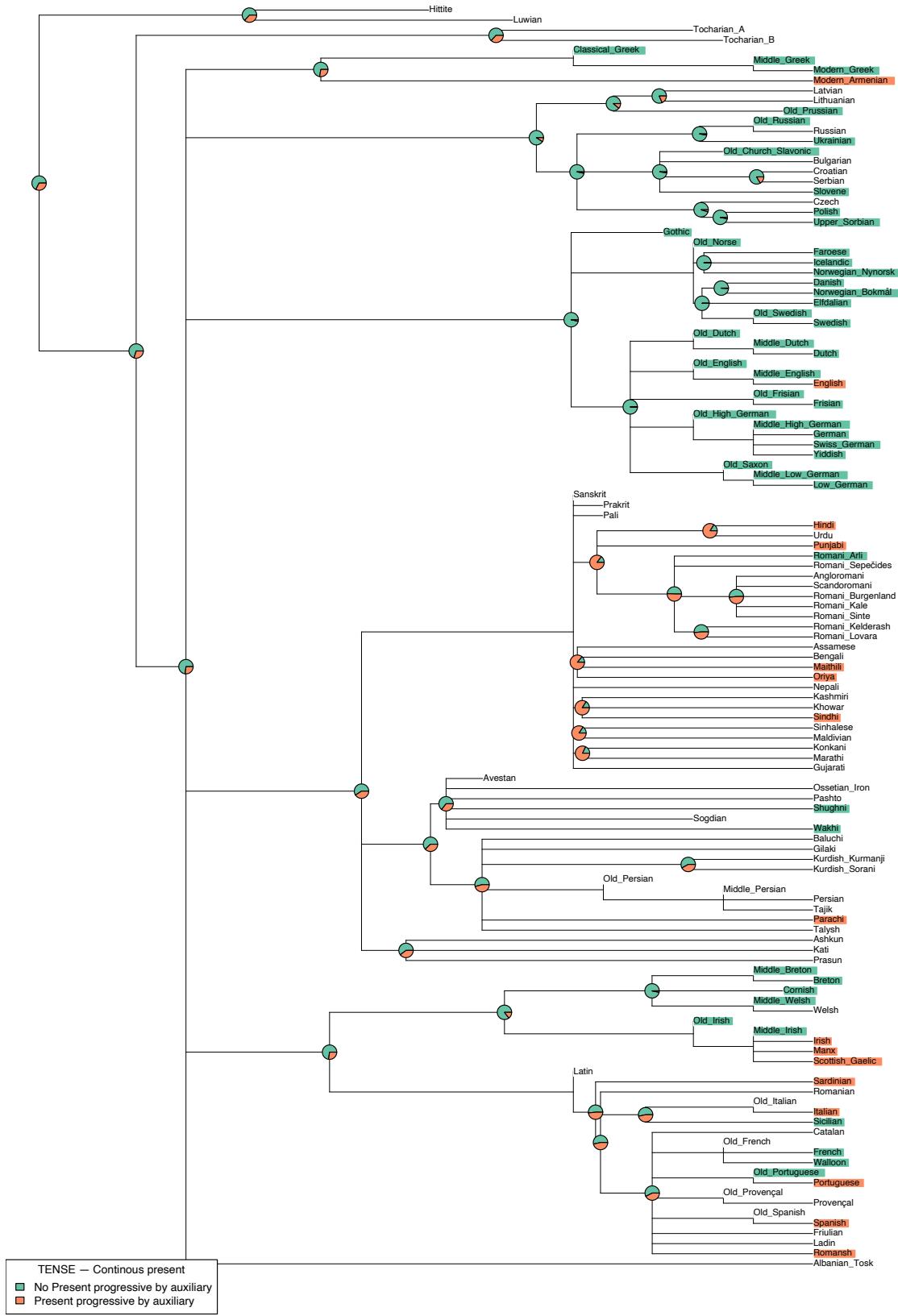


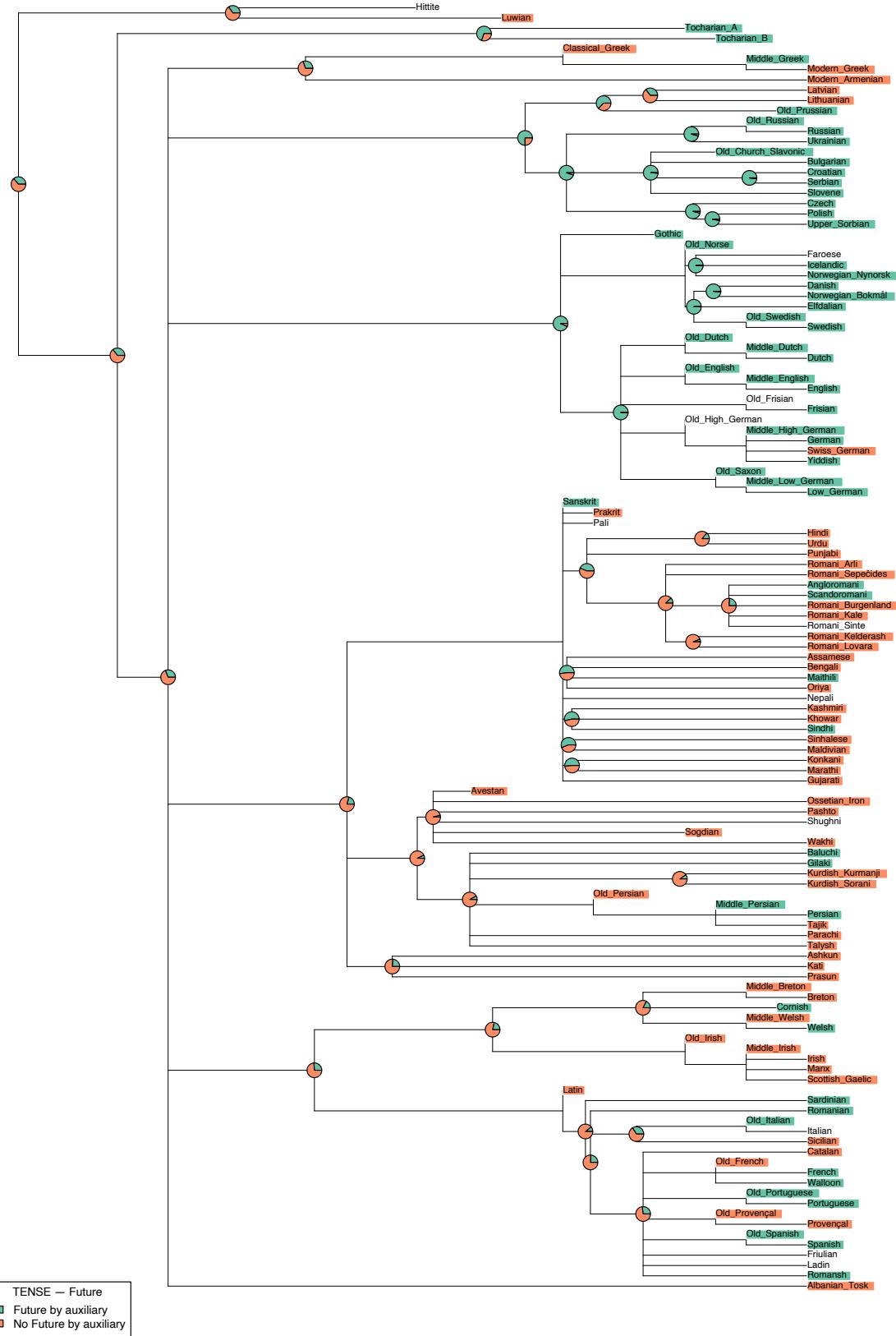


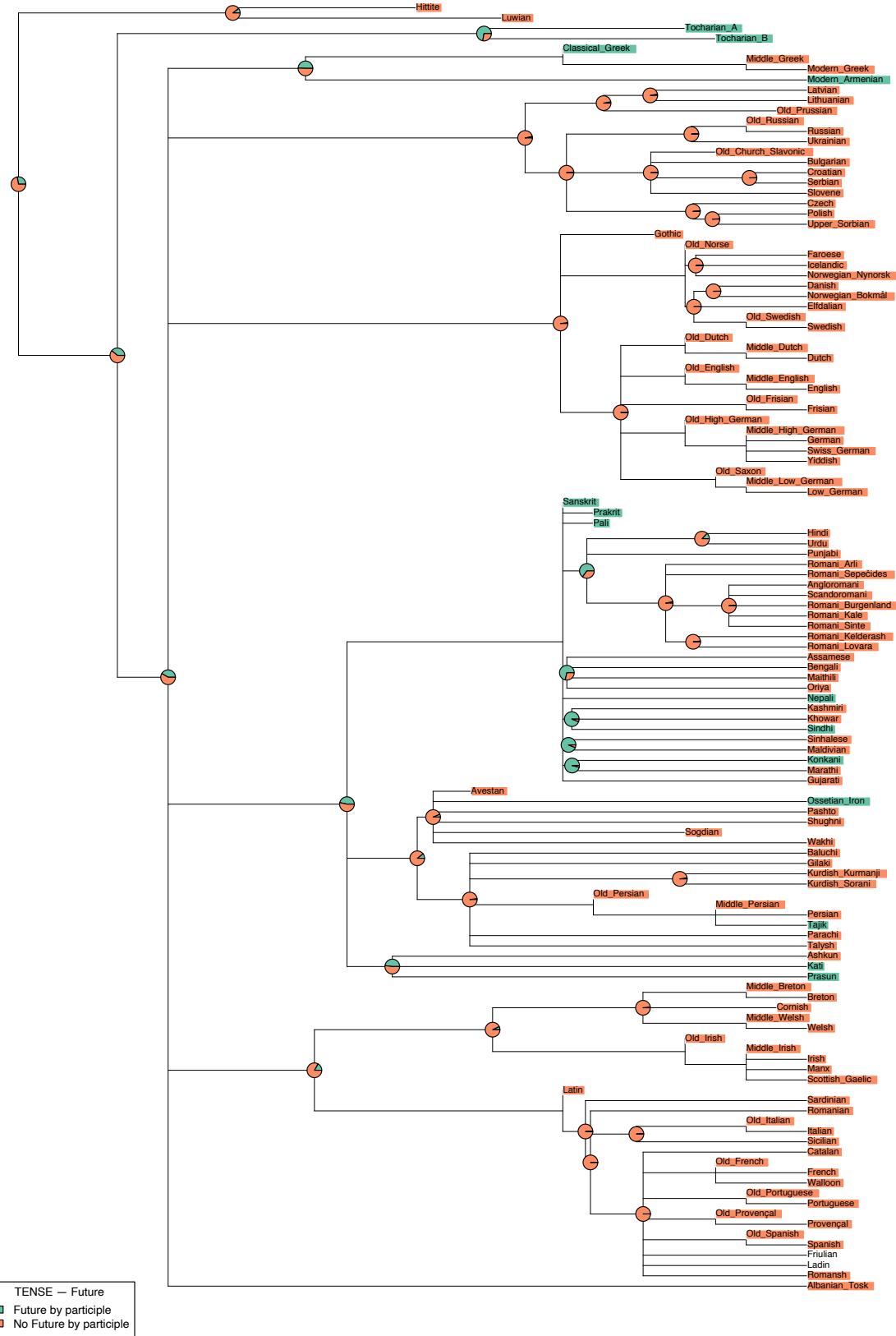


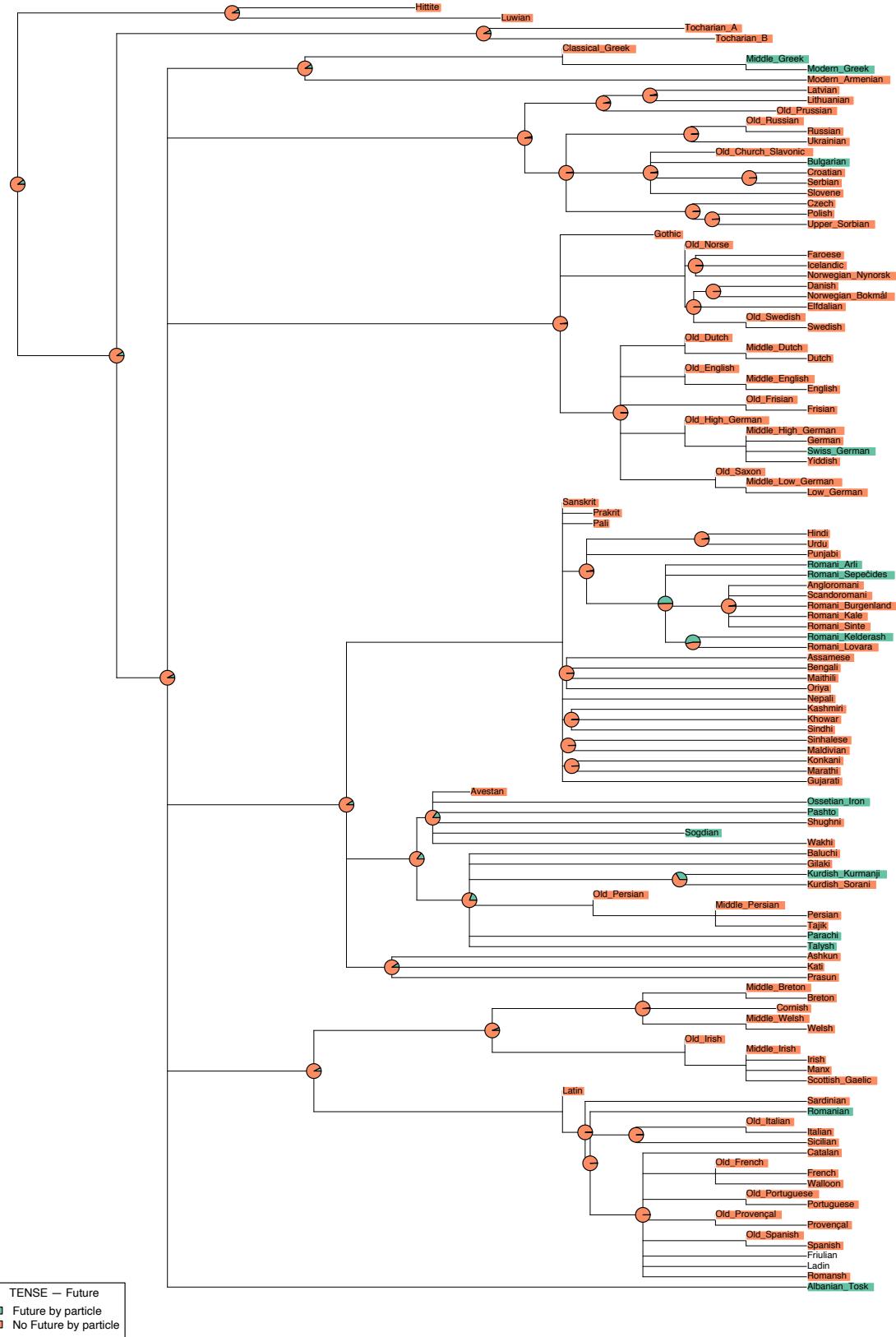


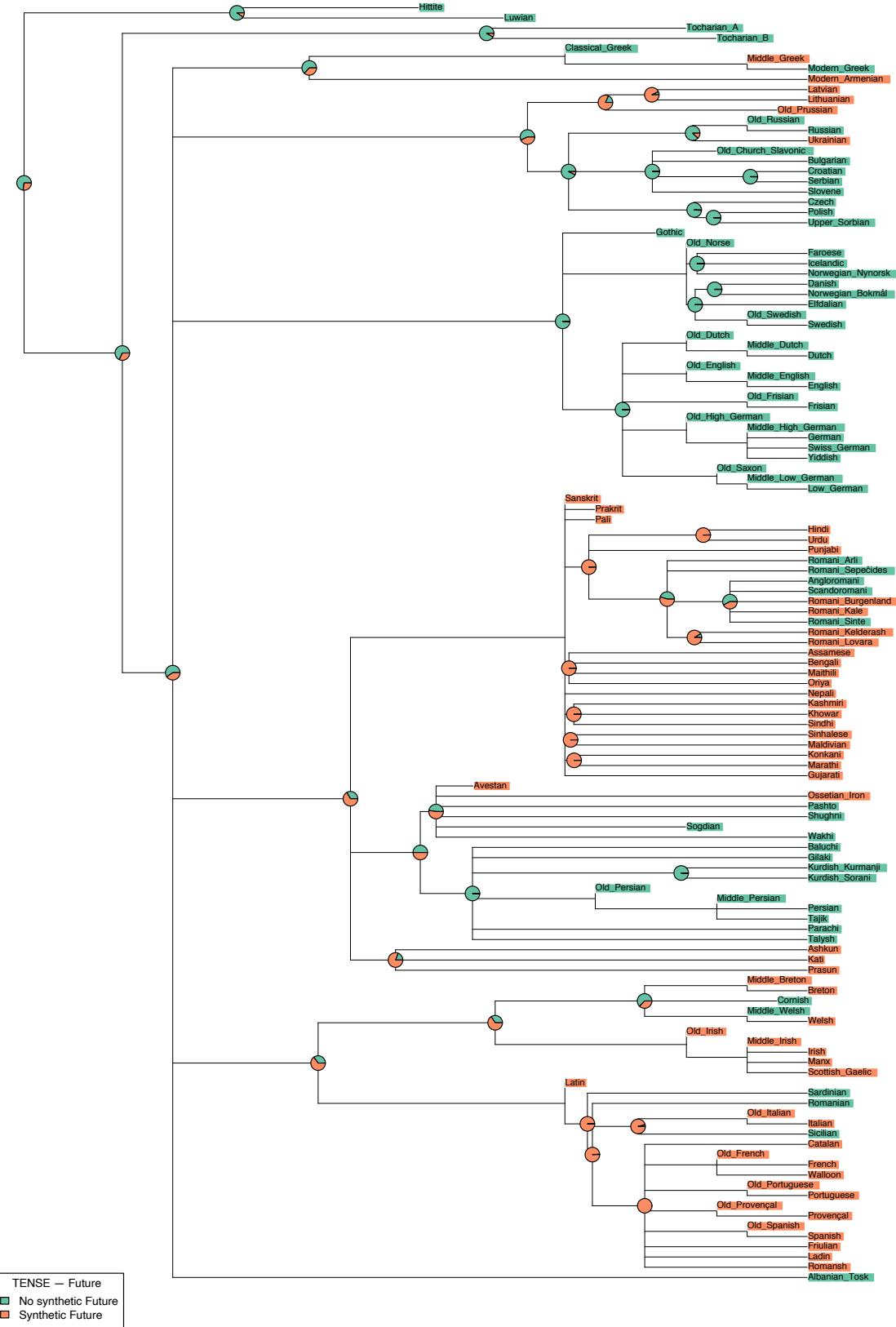


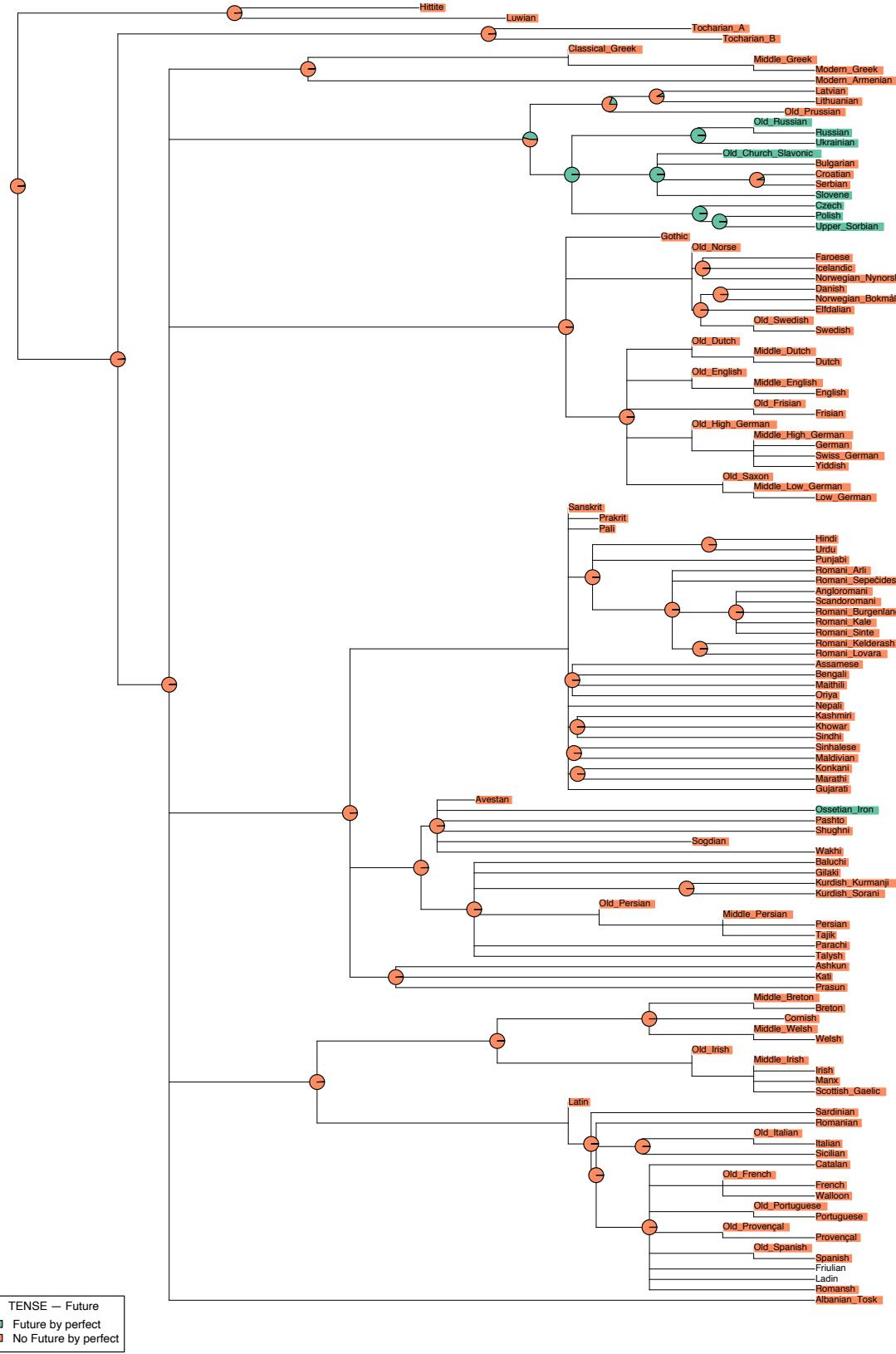


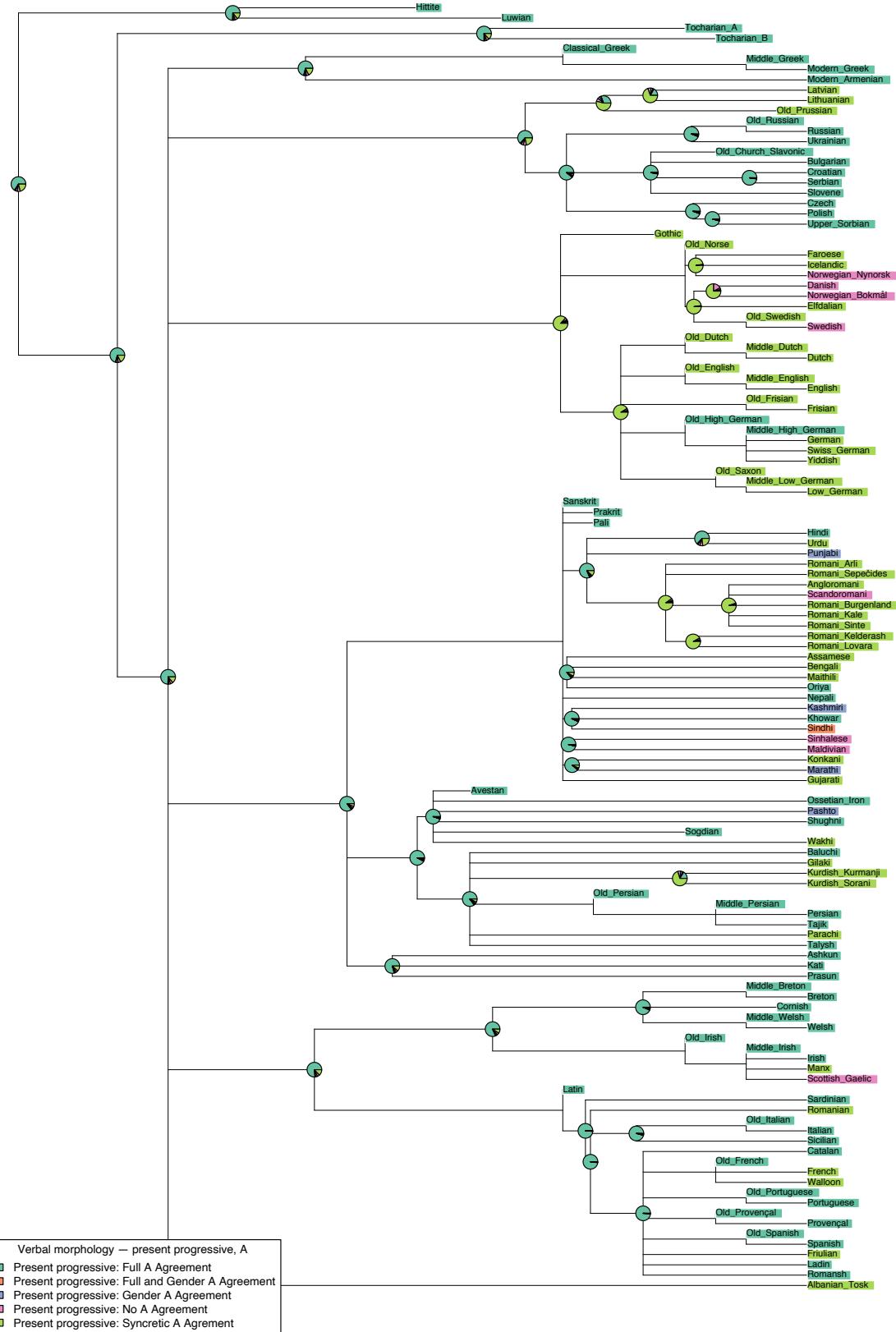


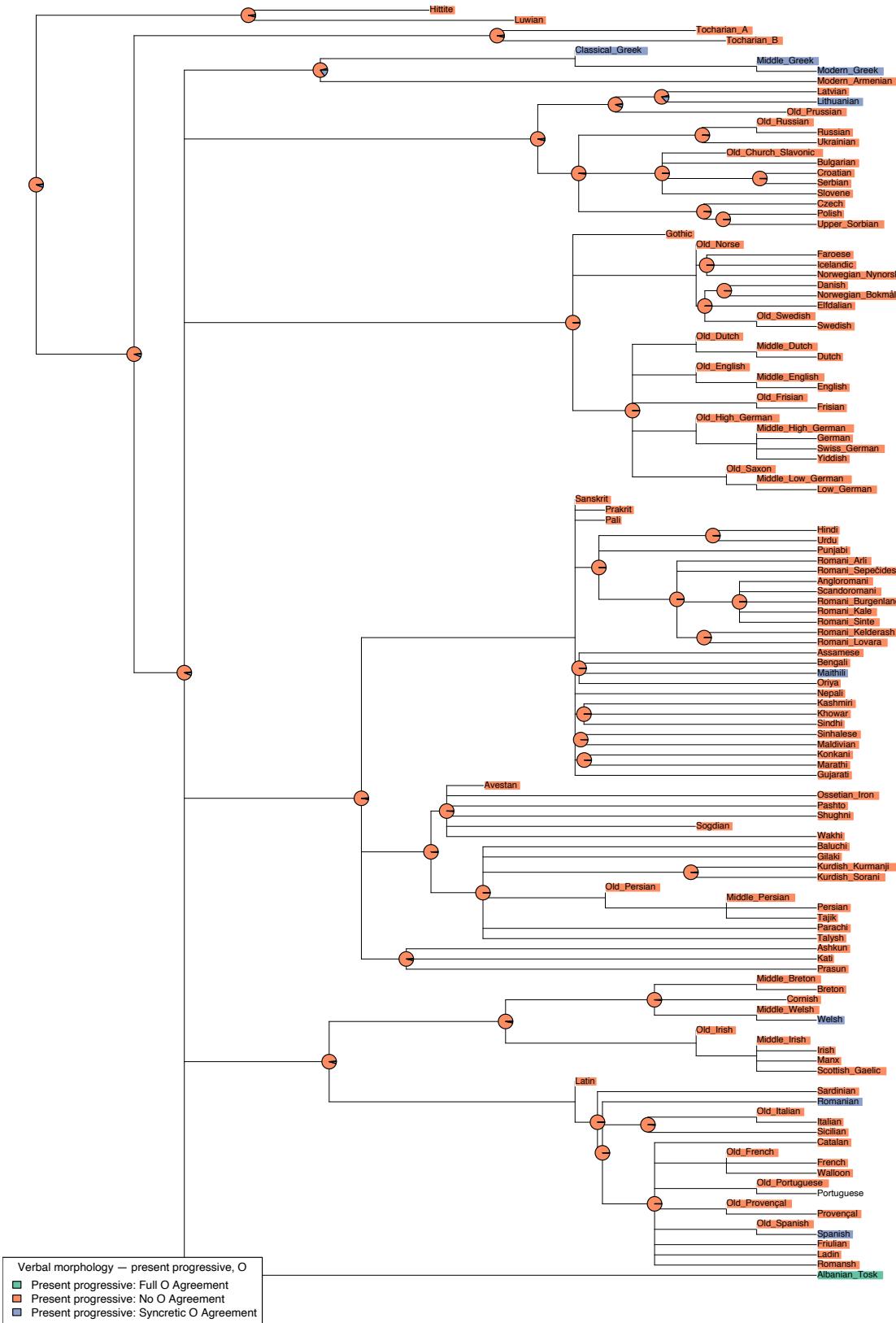


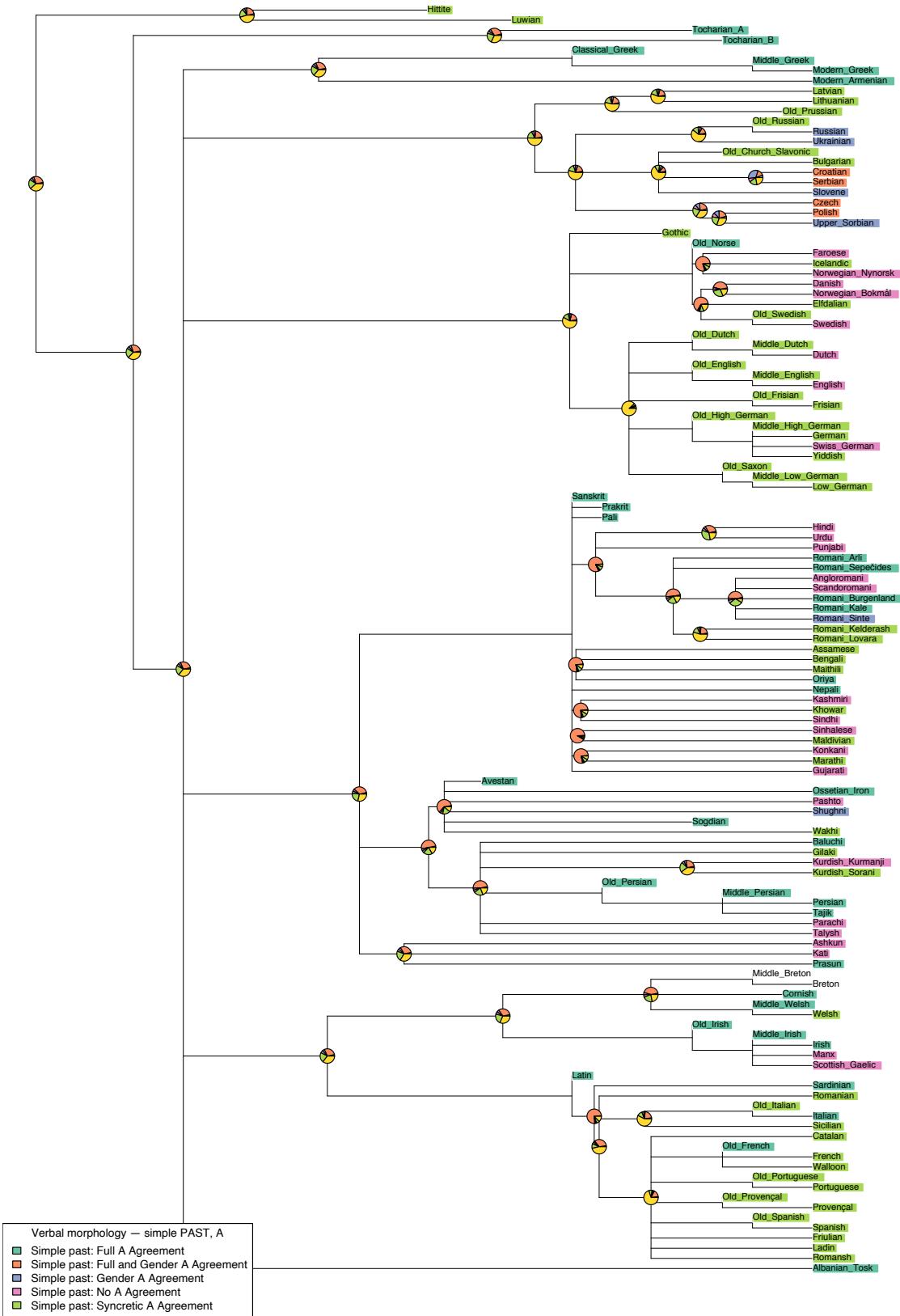


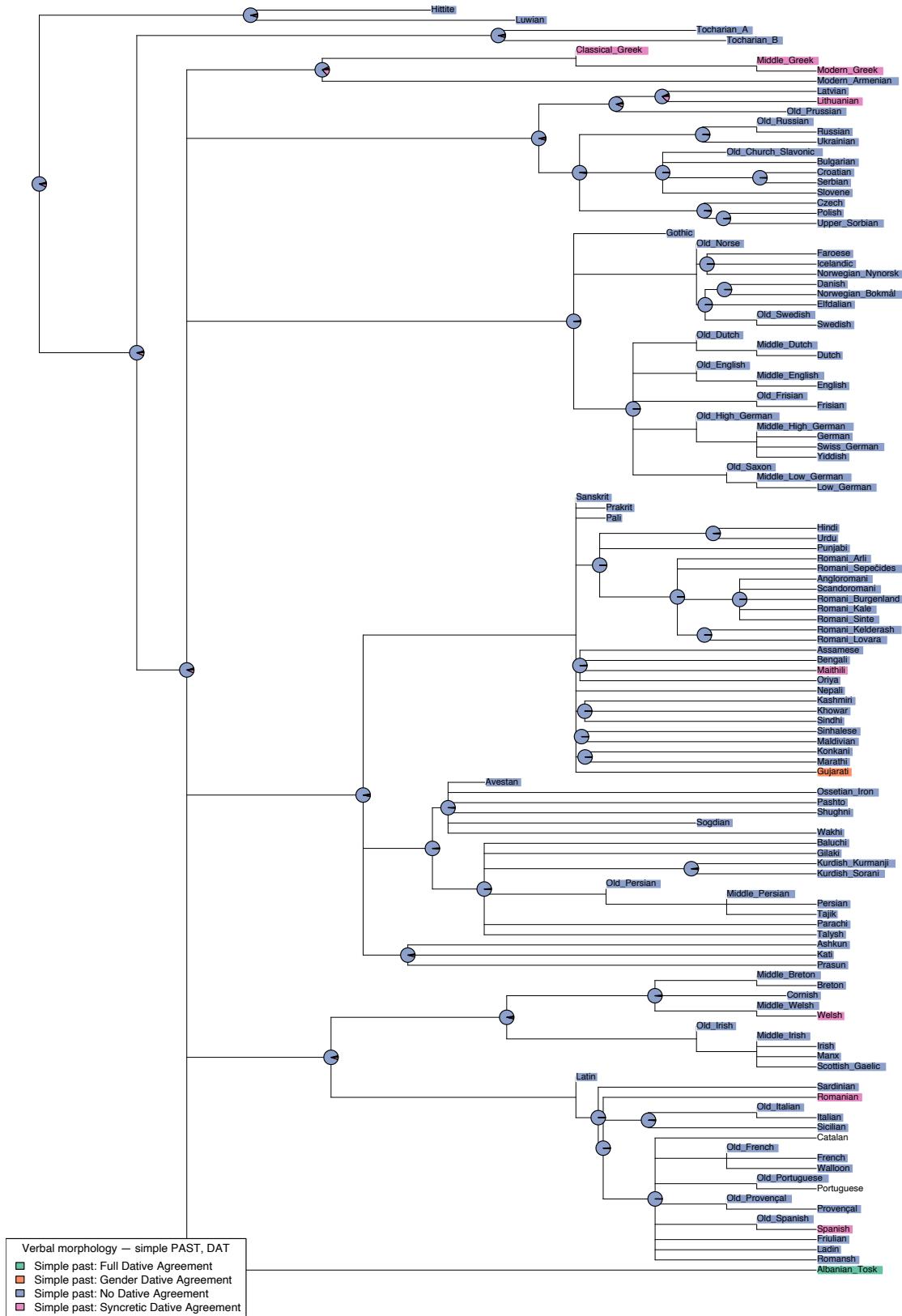


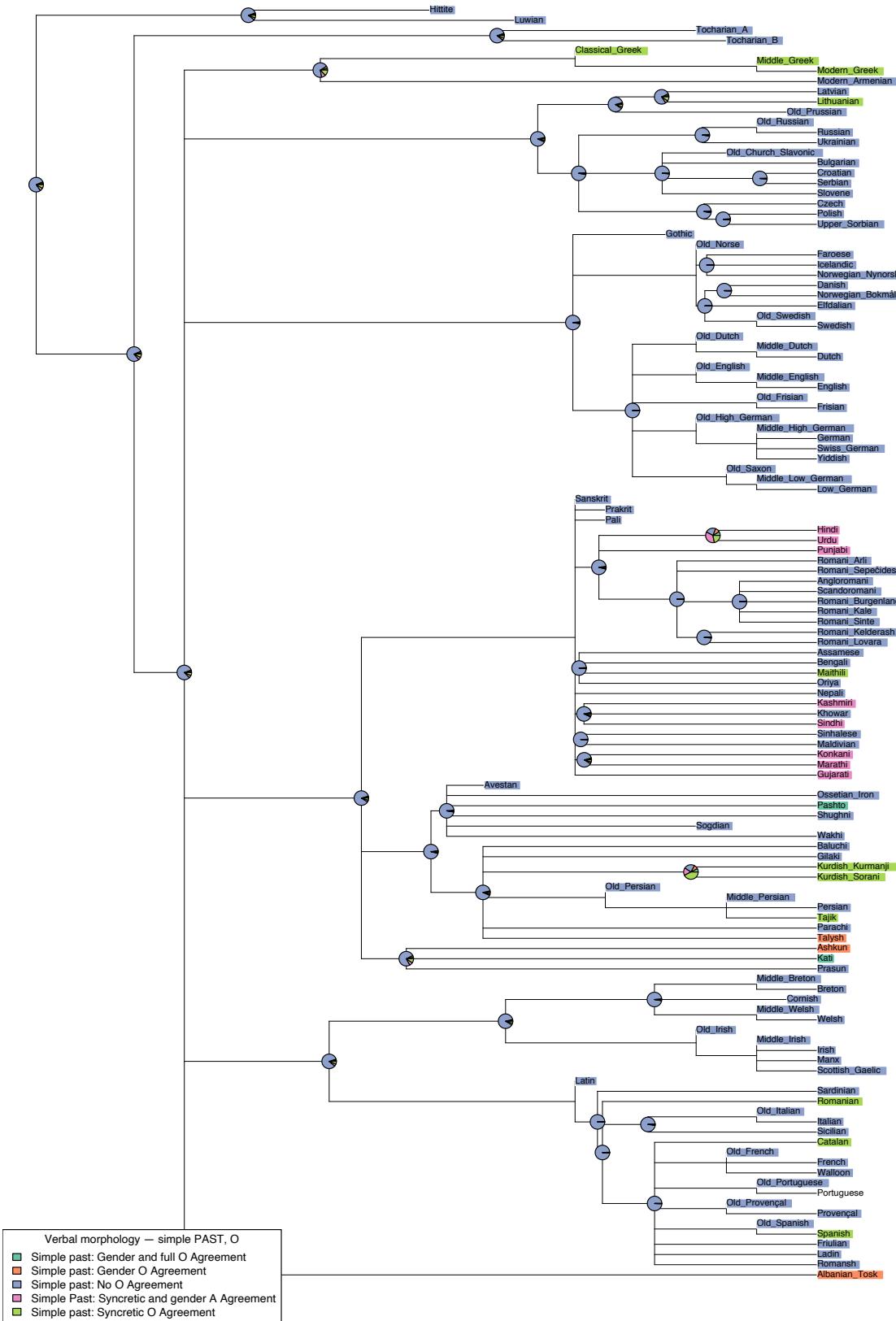


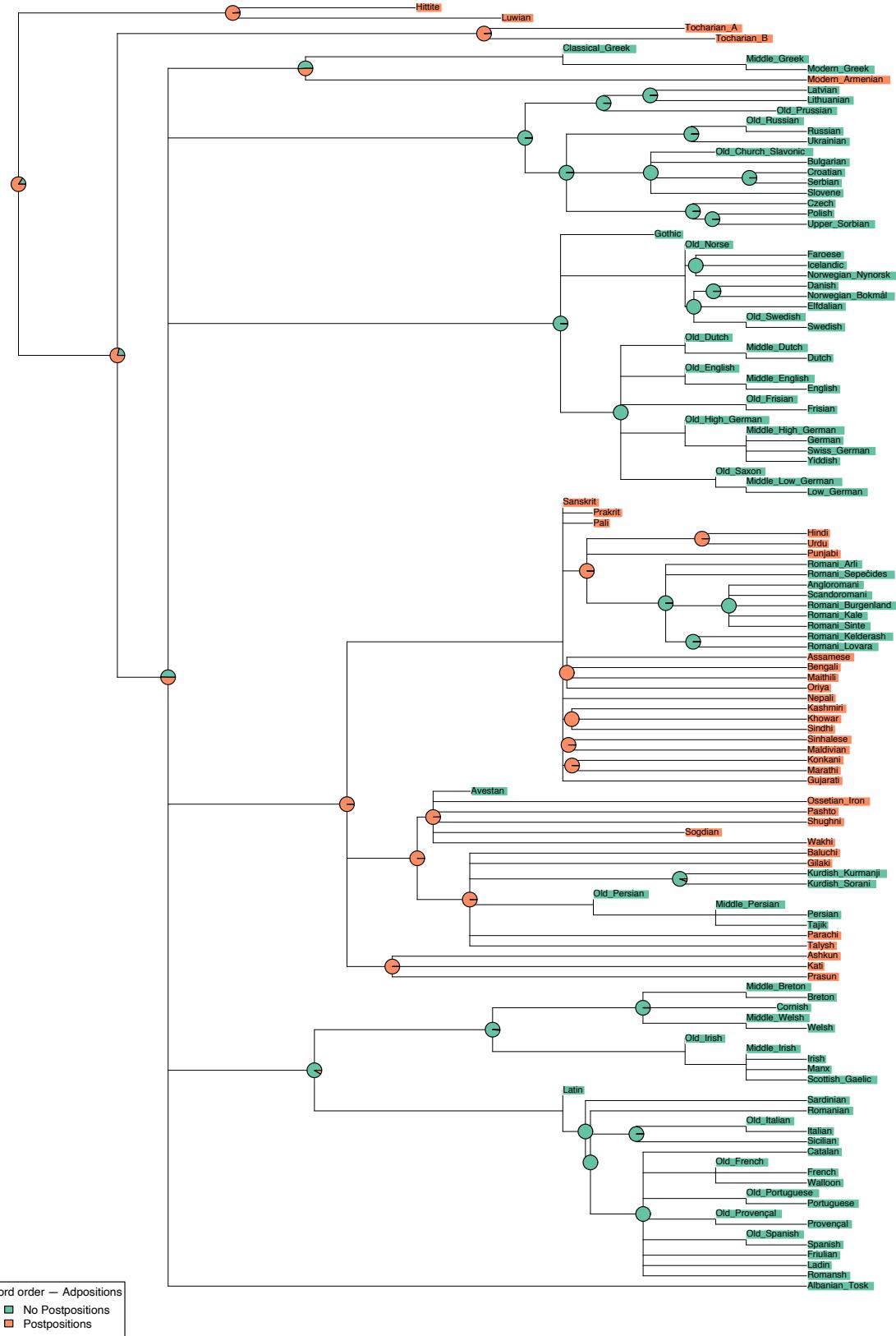


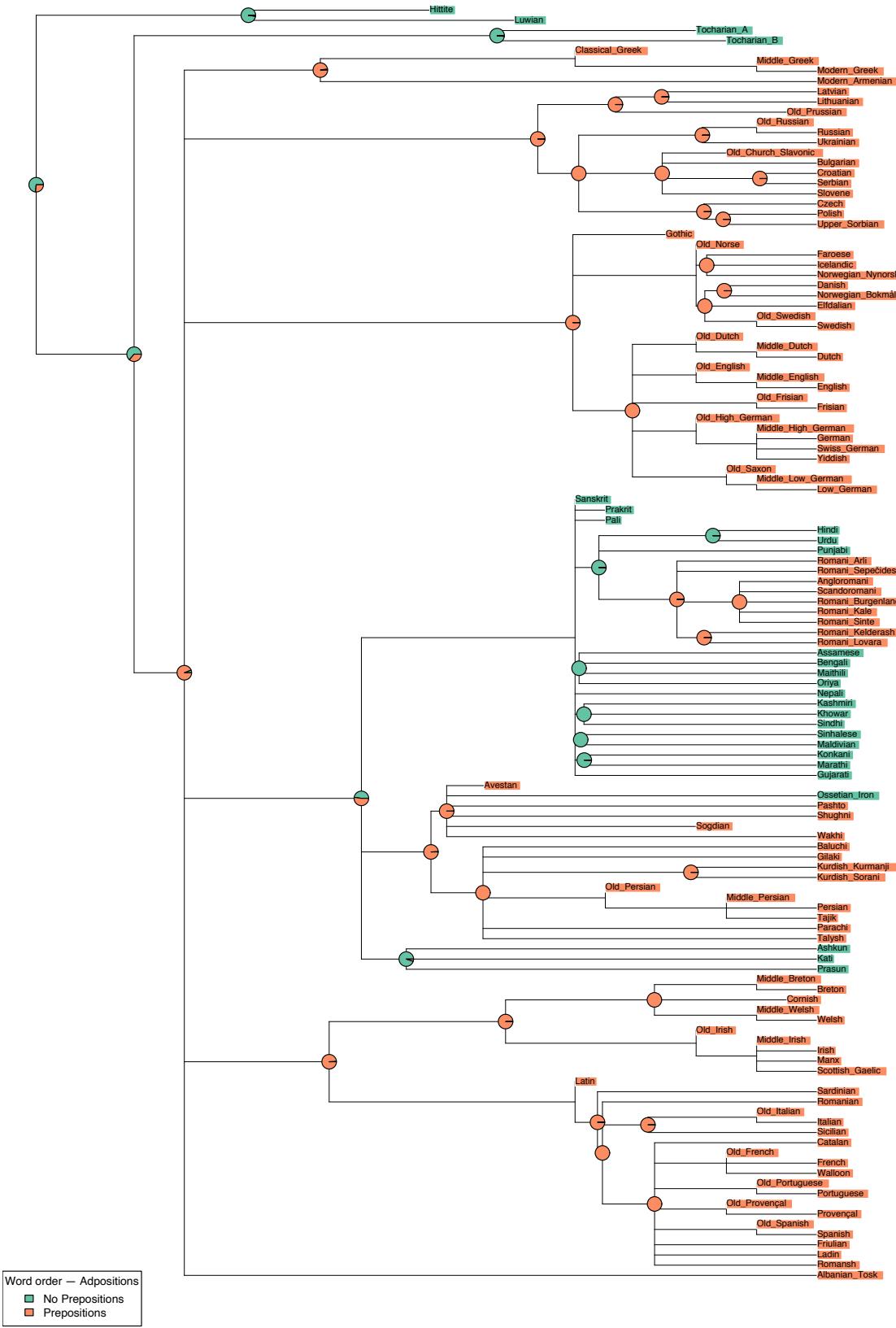


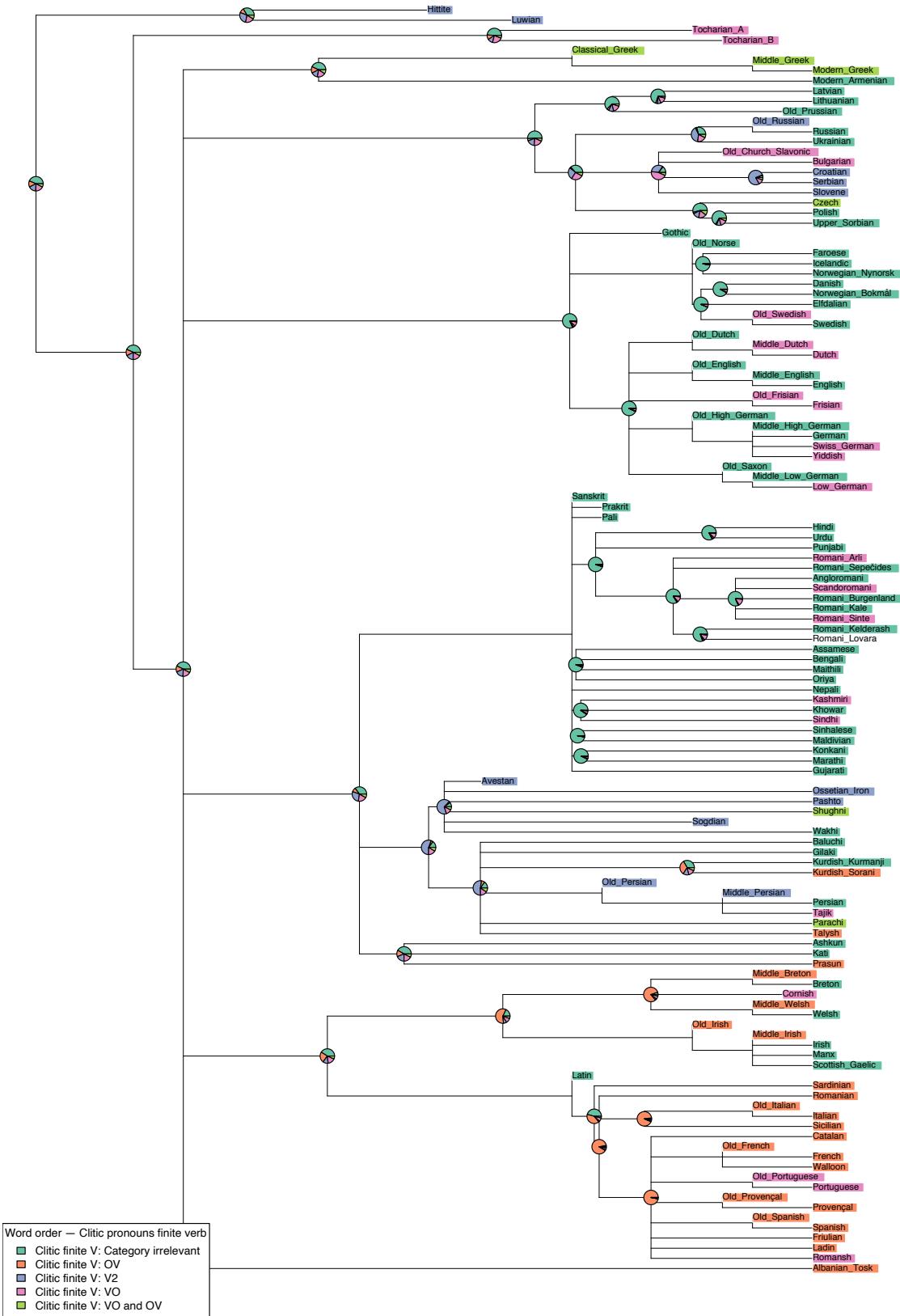


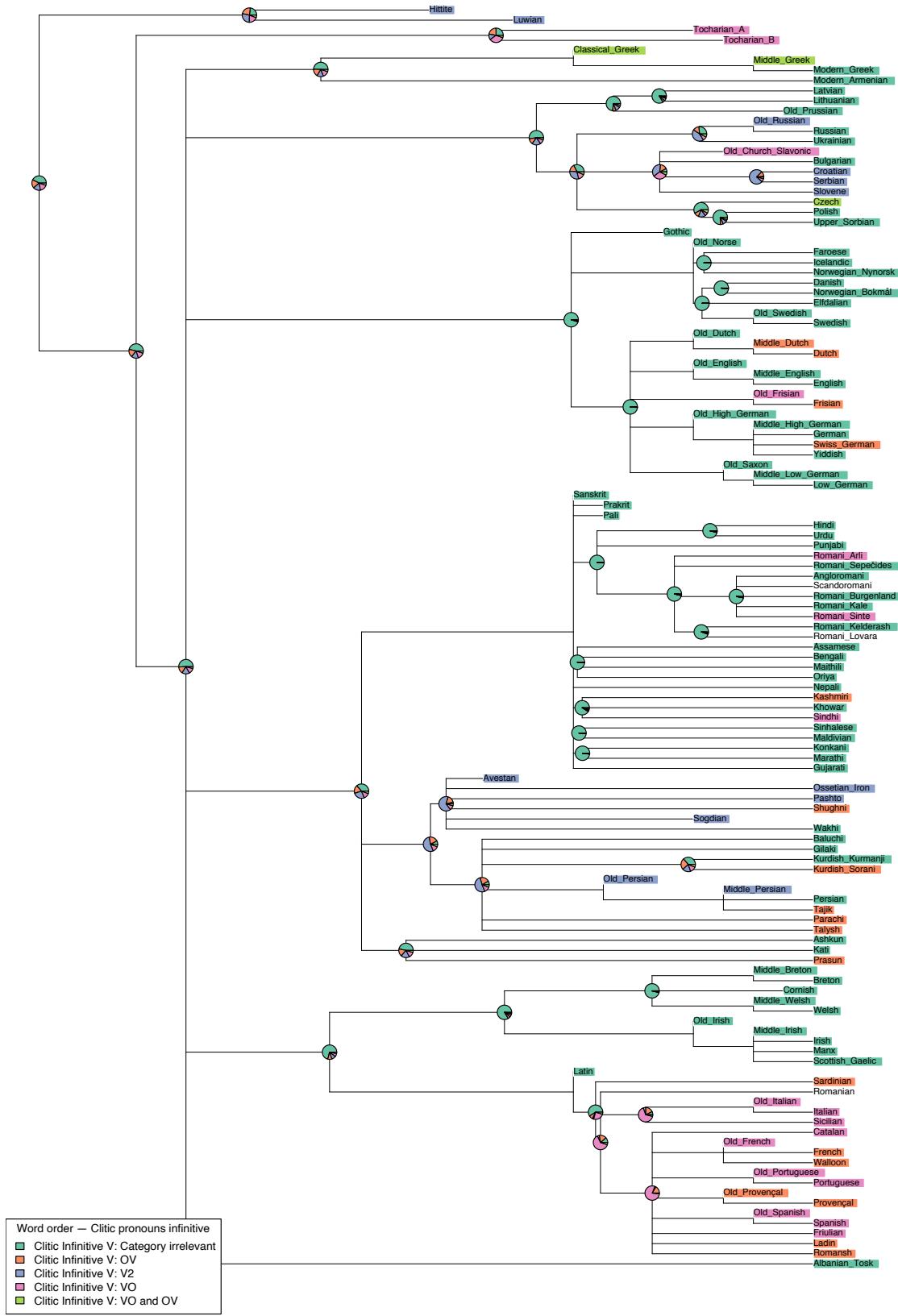


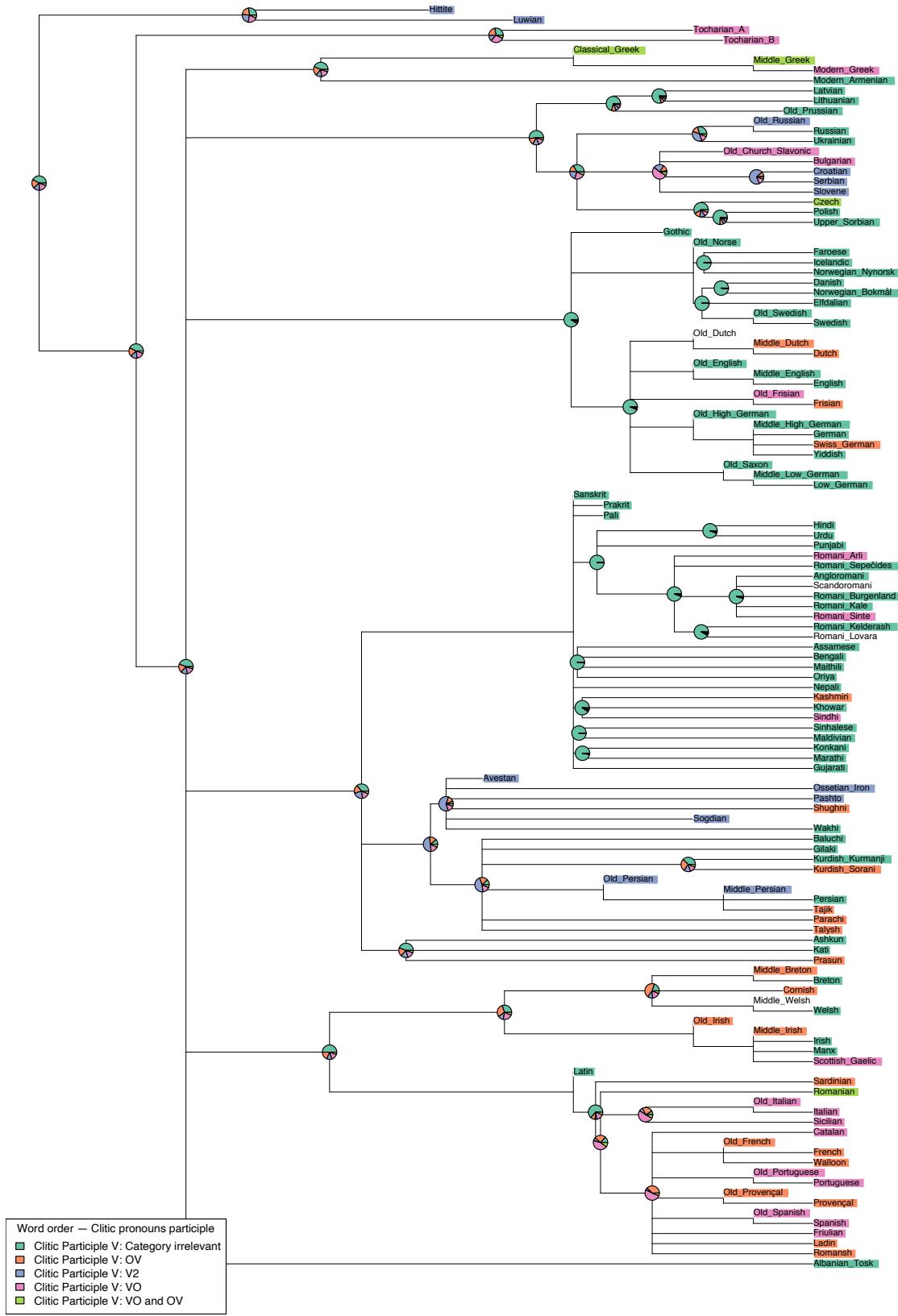




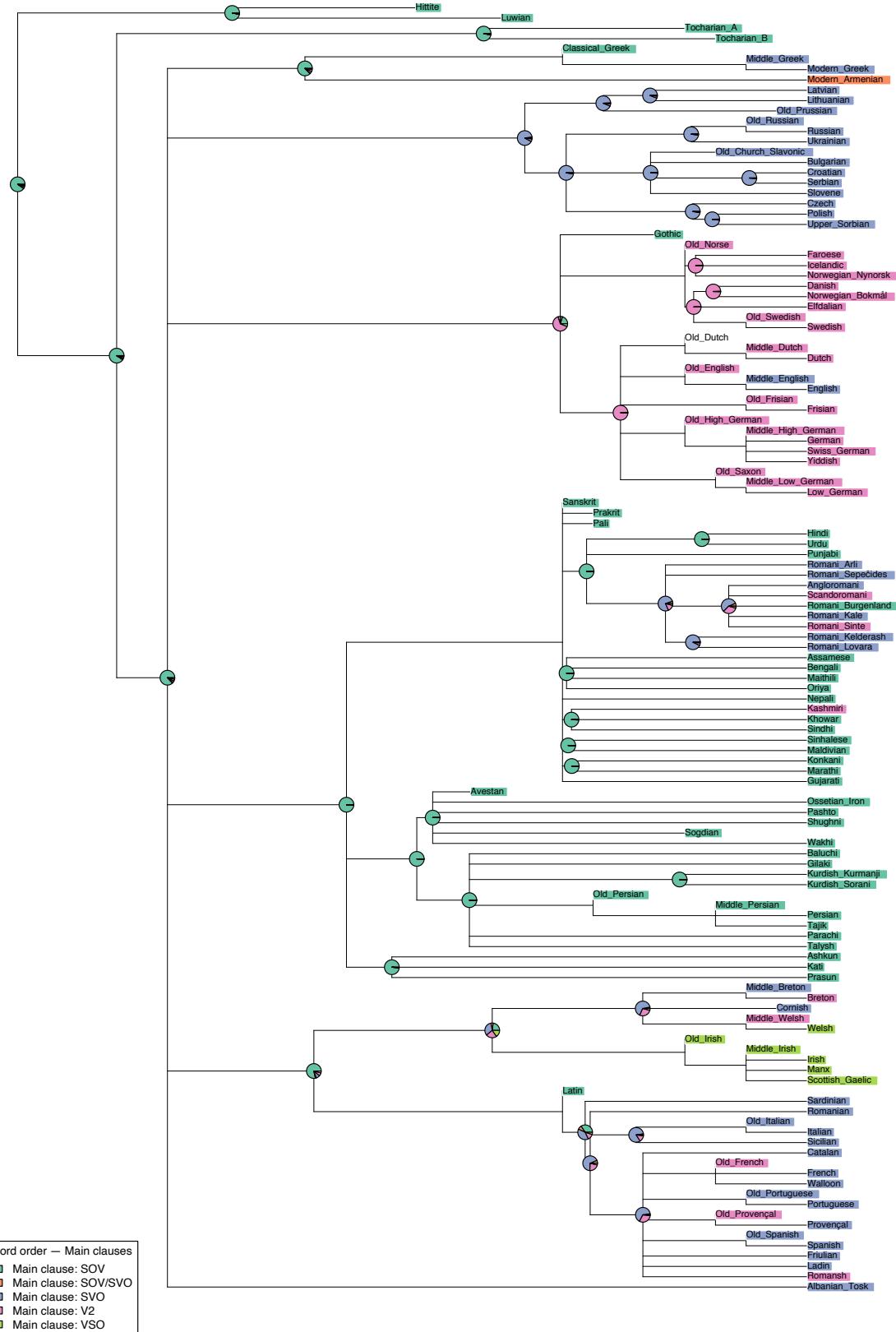


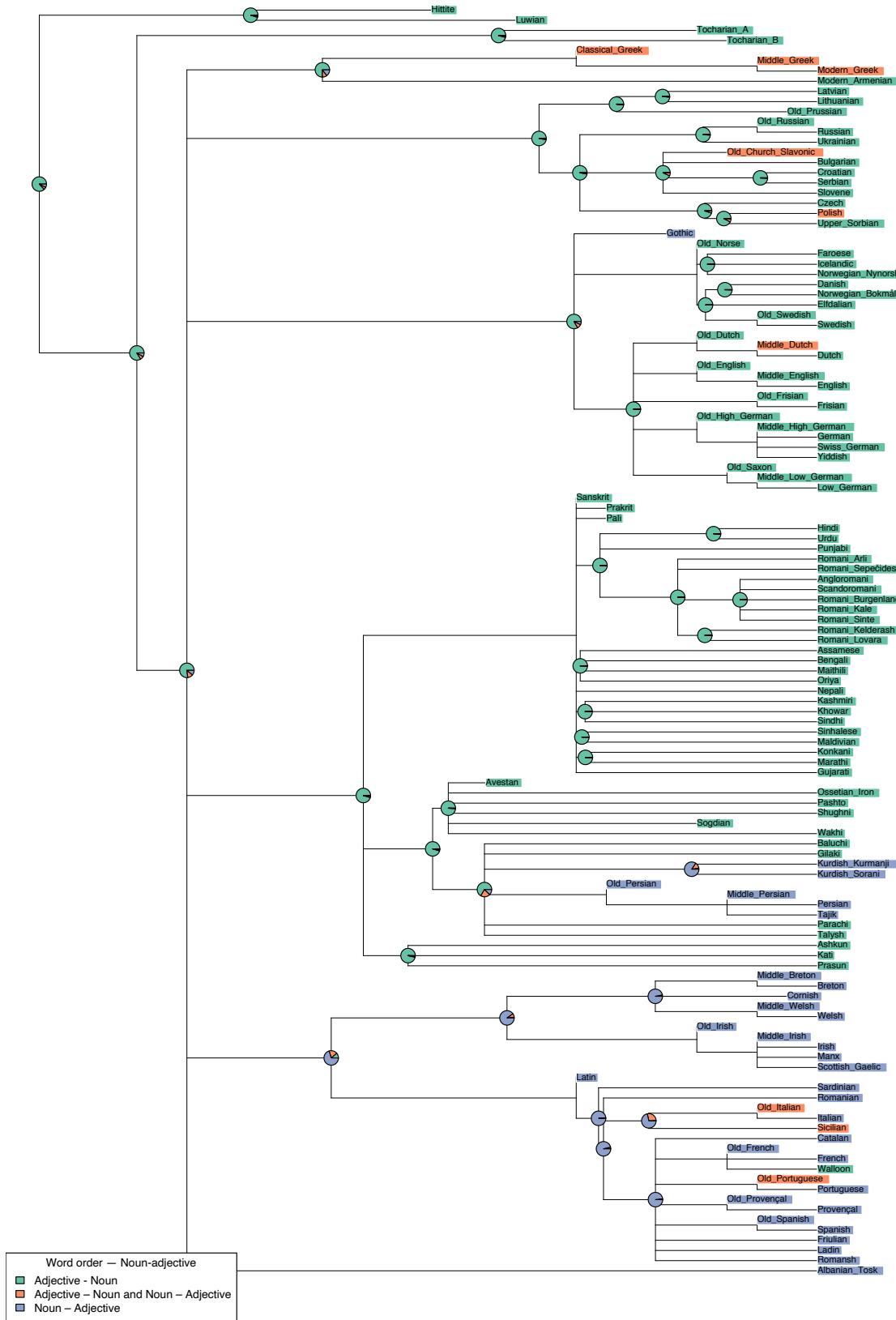


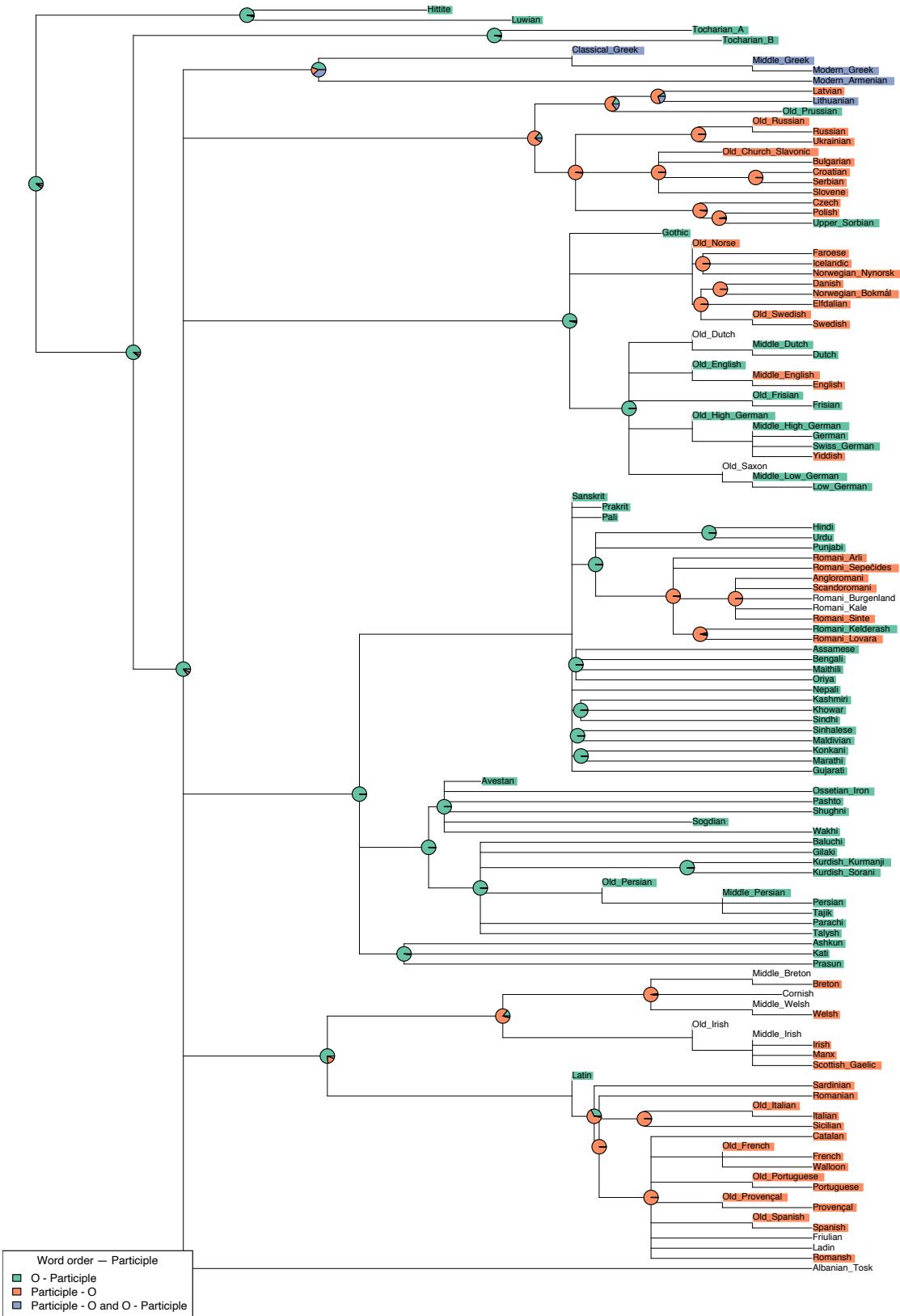


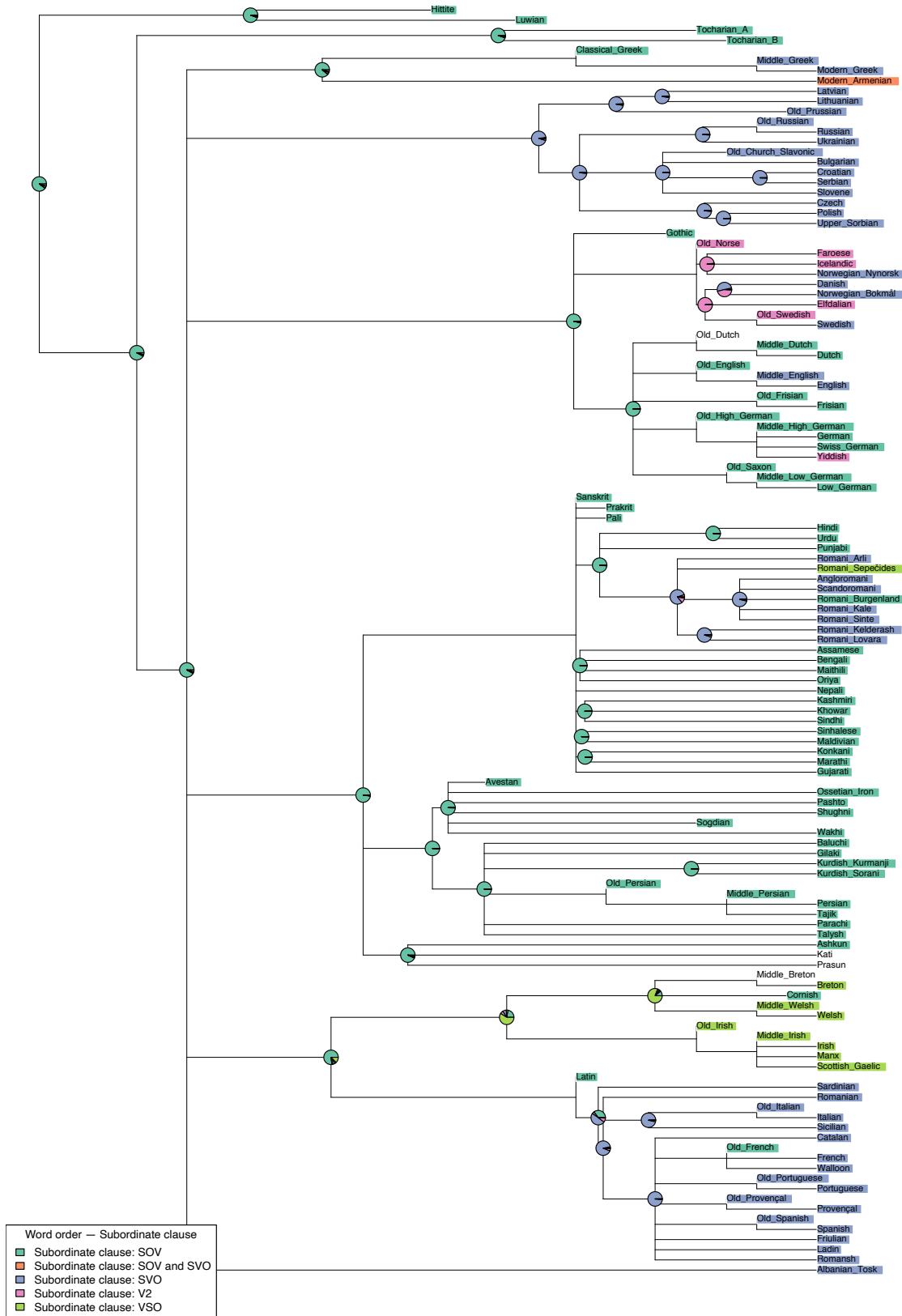


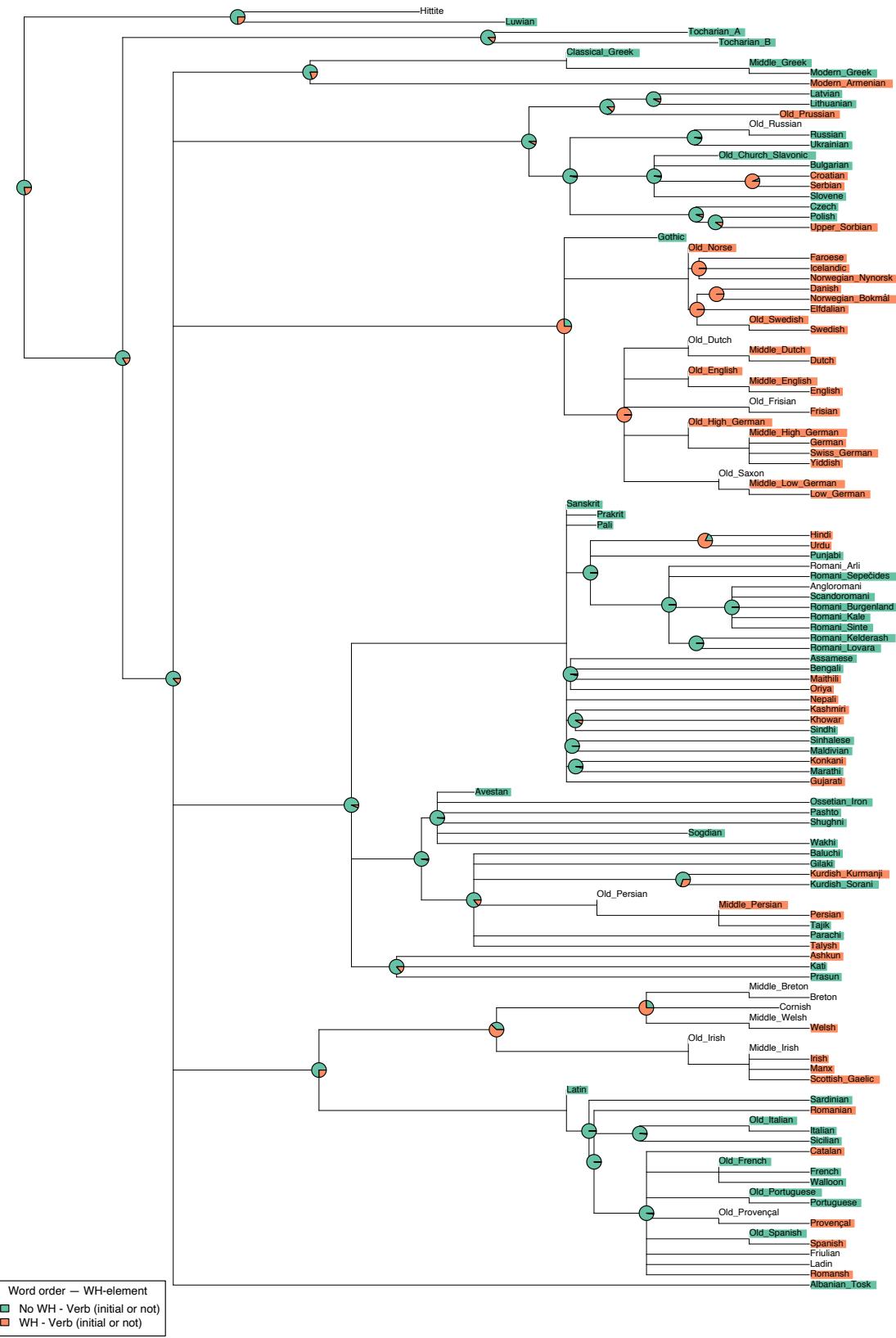


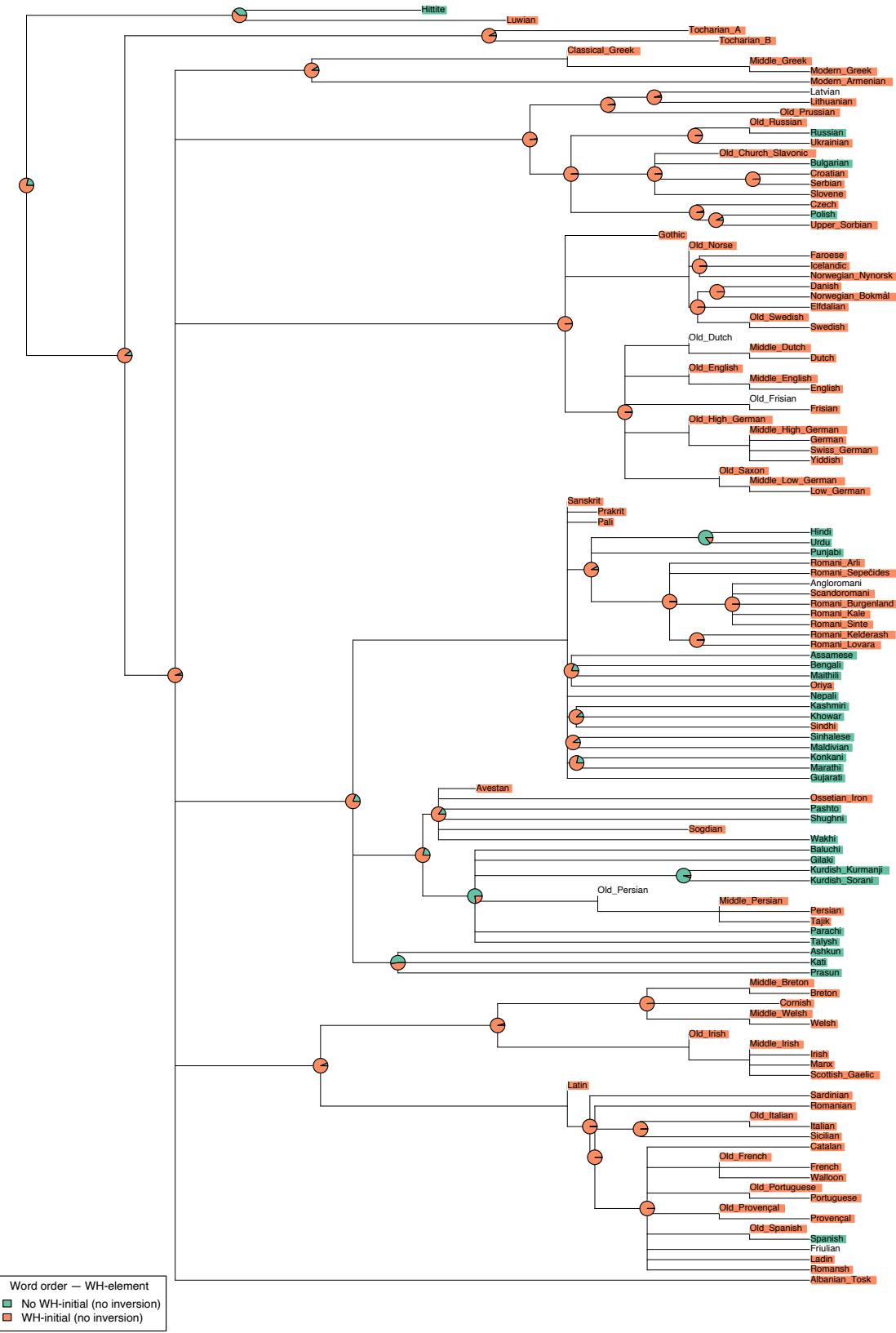












S9

Tree sample of Indo-European languages used for this paper's experiments.

