

## Discussion

1 Comparative cross-cultural studies of folklore have long been  
dogged by debates concerning the durability and integrity of oral  
traditions. While proponents of the historic-geographic approach  
have suggested that similar tales from different cultures can be  
5 grouped into distinct “international types” based on common origins,  
critics have insisted that folktales are too fluid and unstable to be  
classified into groups based on descent [14]. To address this problem,  
the present study employed three methods of phylogenetic  
reconstruction together with several techniques for quantifying  
10 the relative contributions of descent versus other processes  
in generating relationships between Little Red Riding Hood and  
other similar tales from around the world.

Overall, the results demonstrate a high degree of consistency  
in the groupings returned by the cladistic, Bayesian and NeighbourNet  
15 analyses. The “treelikeness” of these traditions appears to be  
relatively strong compared to other datasets. The RI of the most  
parsimonious trees (0.72) returned by the cladistic analysis is  
higher than the mean RI of both the cultural ( $n = 21$ , mean = 0.59)  
and biological ( $n = 21$ , mean = 0.61) datasets analysed by Collard et  
20 al. [47]. Simulations of cultural evolutionary processes carried out

by Nunn et al. [48] suggest that datasets that return RIs of 0.60 and above are likely to have been mainly generated by branching phylogenesis. The average delta score (0.3) and Q-residual (0.03) of conflicting signal among taxa measured on the NeighbourNet graph also suggest that the data are quite tree-like. These figures are within the range of values obtained from linguistic cognate vocabulary sets reported in Gray et al. [36], and are actually lower (i.e. more tree-like) than typological features. However, it is worth noting that it is possible to obtain lower values than the ones reported here from datasets that include known borrowings and even hybrid languages. For example, Gray et al. report that a splits graph of 12 Indo-European languages based on data including loan words and the creole language Sranan yielded an average delta score of 0.23 and a Q-residual of 0.03. In other words, while relationships among the folktales fit a branching model of descent quite well, borrowing and blending could have potentially played a more significant role than indicated by the RI of the MPTs. This would be consistent with the low bootstrap support and posterior probabilities for some of the clades returned by the cladistic and Bayesian analyses. Like the NeighbourNet graph, both these analyses indicate conflicting signal surrounding the East Asian group, as well as among geographically proximate variants of ATU 333 and ATU 123.

However, it is important to emphasise that even when there is a substantial degree of blending and/or convergence among lineages, it is still possible to reconstruct robust cultural phylogenies [48], [49]. In this case, the accuracy of the relationships depicted in Figures 2, 3, and 4 is supported by qualitative evidence regarding the historiography of the tales. Thus, all three analyses identified Little Red Riding Hood, The Story of Grandmother and Catterinella as a single tale type that is distinct from The Wolf and the Kids, which folklorists believe to be a more distantly related tale [11]. In accordance with the chronological record, relationships within the ATU 333 group indicate that Little Red Riding Hood and the Story of Grandmother are descended from a common ancestor that existed more recently than the last ancestor they share with the 11<sup>th</sup> century Liège poem, [40]. The position of the Grimms' version of Little Red Riding Hood supports historiographical evidence that it is directly descended from Perrault's earlier tale (via a literate informant of French Huguenot extraction) [37]. The results of the analyses also concur with the literary record on The Wolf and the Kids, which suggests the tale evolved from an Aesopic fable which was first recorded around 400 AD [46]. All three analyses indicate that Aesopic versions of the tale - in which the victim sees through the villain's disguise before letting him through the door - diverged at an early point in the history of the lineage, prior to the existence of the last

common ancestor shared by other variants of The Wolf and the Kids.

In sum, the consistency of the relationships returned by different phylogenetic methods, their fit to the data, and their compatibilities with independent lines of folklore research provide compelling

70 evidence that - contrary to the claim that the vagaries of oral transmission are bound to wipe out all traces of descent in folktales - it is possible to establish coherent narrative traditions over large geographical distances and historical periods.

While these findings broadly support the goals of historic-geographic

75 approaches to folklore, they also demonstrate that phylogenetic analysis can help resolve some the problems arising from more traditional methods. As mentioned previously, one of the key problems with existing folklore taxonomy is that it defines international types in reference to European type specimens on the basis of just

80 a few traits. In this case, African and East Asian tales are grouped with Little Red Riding Hood because they feature human protagonists, and with The Wolf and the Kids because the villain attacks the victims in their own home, rather than their grandmother's. The phylogenetic approach used here, on the other hand, defines types in reference

85 to the tales' inferred common ancestors rather than any existing variants, and uses all the traits they exhibit as potential evidence for their relationships. This approach yielded clear evidence that the African tales are more closely related to The Wolf and

the Kids than they are to Little Red Riding Hood. All the analyses  
90 clustered the African stories with ATU 123. The sole exception was  
an Ibo tale, which grouped with European variants of Little Red  
Riding Hood, thus endorsing the collector's belief that the story is  
not of local origin, but an Ibo oral translation of the western fairy  
tale [50]. The other African tales, on the other hand, seem to have  
95 been derived from the European/Middle Eastern tale of The Wolf and  
the Kids, perhaps as a result of trade or colonialism. The tale was  
subsequently modified to create a novel redaction that spread across  
central and southern societies on the continent, and even as far  
as Antigua. Although bootstrap and posterior support for this clade  
100 was relatively modest, it is remarkable that the phylogenetic signal  
in this tradition was sufficiently strong to be detected by all  
three analyses, despite the massive cultural and human upheavals  
that occurred during the forced displacement of African populations  
during the slave trade.

105 The East Asian tales, meanwhile, did not cluster with ATU 333 or  
ATU 123, but formed a separate group. Since there is no evidence  
to suggest they share a more recent common ancestor with The Wolf  
and the Kids or Little Red Riding Hood, they cannot be classified as  
members of either international type. One intriguing possibility  
110 raised in the literature on this topic that would be consistent  
with these results is that the East Asian tales represent a sister

lineage that diverged from ATU 333 and ATU 123 before they evolved into two distinct groups. Thus, Dundes has proposed that the East Asian tradition represents a crucial "missing link" between ATU 333 and ATU 123 that has retained features from their original archetype [38]. A more detailed exposition of this theory has been set out by the Sinologist Barend J. ter Haar [51]. Noting that the The Tiger Grandmother encompasses a spectrum of more ATU 333-like variants and more ATU 123-like variants, Haar argues that the East Asian tales represent an ancient autochthonous tale type that is ancestral to the other two. On the basis of qualitative comparisons among these and other Asian tales, he conjectures that the tale originated in China and spread westwards to the Middle East and Europe between the twelfth and fourteenth century, a period during which there were extensive trade and cultural exchanges between east and west. At some unspecified later point, the tale type split into the lineages that gave rise to Little Red Riding Hood and the Wolf and the Kids. Although it is tempting to interpret the results of the analyses in this light, there are several problems with this theory. First, the earliest known version of the East Asian tale was recorded sometime in the early eighteenth century by the Chinese writer Huang Zhijun [52], thirteen hundred years after the publication of the earliest Aesopic version of ATU 123 [46], and eight centuries after the medieval variant of ATU 333 was written in Liège [40].

135 Of course, as mentioned previously, literary evidence about  
the origins of oral tales can be unreliable and biased toward Europe.  
However, at the very least, the existence of ATU 123 in first century  
Europe means that the putative Asian ancestral tale type would  
have to had to have spread west long before the opening of trade  
140 routes in the twelfth to fourteenth centuries, as suggested by Haar  
[51]. Second, if ATU 333 and ATU 123 are more closely related  
to each other than they are to the East Asian tales, they would  
be expected to share derived characters (i.e. novel story traits)  
that would have evolved after they diverged from the East Asian  
145 tradition. However, there is not a single characteristic shared  
by these two tale types that does not also occur in the East Asian  
group. Third, there is little evidence to support the contention  
that resemblances between the East Asian tales and ATU 333 and ATU  
123 are primitive. If that were the case, we would expect earlier  
150 versions of ATU 123 and ATU 333 to be more similar to the East  
Asian tales than later variants, as original elements of the story  
would be lost or substituted as each tradition evolved. However,  
this prediction is contradicted by the available chronological  
data on the tales' histories. For example, some Chinese tales  
155 feature an episode that occurs in many versions of The Wolf and  
the Kids in which the children, suspecting that the villain may not  
really be their mother/grandmother, ask him to show them his hand

through the door before letting him in. In ATU 123, this test first appears in a version of the fable recorded in the fourteenth century [46], and is lacking in the original version. Similarly, in Japanese, Korean and some Chinese tales the villain drinks oil/spring water to clear his throat after his initial attempts to impersonate the children's mother's voice failed. An almost identical episode occurs in variants of The Wolf and the Kids (and is also present in the African tales), in which the wolf drinks something or cuts his tongue to smooth out his voice. However, it does not appear in any recorded versions prior to the publication of the Grimms' Children and Household Tales in 1812 [1].

Similarities between the East Asian tales and ATU 333 are similarly lacking in the earliest variant, the medieval poem from Liège. They include the famous dialogue in which the victim (s) questions the "grandmother" about her strange appearance ("What big eyes you have!"), the rescue by a passing woodcutter, and the victim's escape, in which she tricks the villain into letting her go outside to go to the toilet. The latter trait has excited particular interest among folklorists, since it occurs in the oral tale The Story of Grandmother and not in Little Red Riding Hood (where the girl gets eaten). The presence of this same episode in the East Asian tradition has been cited as one of the main pieces of evidence that The Story

180 of Grandmother is a more archaic version of the tale than Perrault's, making its absence in the Liège tale all the more conspicuous.

Bearing in mind the limitations of relying on chronological evidence about the evolution of folktales, we should consider the possibility that neither the Liège tale, nor the Aesopic fable, 185 provide accurate representations of the early forms of ATU 333 and ATU 123, leave alone their last common ancestor. To investigate the evolution of these similarities more rigorously, the ancestral states of the traits discussed above were reconstructed on the tale phylogenies (see Methods for details). The results are shown in Table 190 1 below. The analyses indicate that the aforementioned similarities between the East Asian tales and ATU 333 and ATU 123 were highly unlikely to have been present in the putative archetype shared by the latter two groups, contradicting the hypothesis that the East Asian tales provide a "missing link" between the two traditions.

195 An alternative - and, to the best of this author's knowledge, novel - explanation for the relationship of the East Asian tales to ATU 333 and ATU 123 is that the former is derived from the latter two, rather than vice versa. This would mean that The Tiger Grandmother represents a "hybrid" tale type, which evolved by blending together 200 elements from ATU 333 and ATU 123 type tales. This hypothesis would account for the finding that important traits shared by the East

Asian tales and Little Red Riding Hood and The Wolf and the Kids are not ancestral, suggesting that they were borrowed instead. Given the number and striking nature of these resemblances, it seems unlikely that they could have evolved independently. Borrowing is also consistent with patterns of conflicting signal in the NeighbourNet graph, which appear to be especially prevalent around the East Asian group. This impression is confirmed by a comparison of taxon-specific delta scores and Q-residuals, which are higher on average for the East Asian tales than other tales. The average delta score of the East Asian tales is 0.31 compared to an average of 0.28 for the other taxa, while their average Q-residual is 0.04 compared to 0.02. To investigate this hypothesis further, another set of analyses were carried out in which the East Asian tales were removed from the data (along with the characters that were only present in this group). It was reasoned that if these tales evolved by blending together elements of ATU 333 and ATU 123 then their removal should result in a more phylogenetically robust distinction between these two groups. This prediction was tested by maximum parsimony bootstrapping and Bayesian inference. For reference, consensus trees derived from both analyses are presented in the Supporting Information, together with a NeighbourNet graph excluding the East Asian tales (Figures S1, S2 and S3). Bootstrap support for the clade separating ATU 333 from ATU 123

225 increased from 62% to 83%, while the Bayesian posterior probability  
rose from 87% to 98%. Thus, both analyses indicate that the East  
Asian tales are a source of conflicting signal in the data, in line  
with the hybridisation hypothesis.

While on current evidence this appears to be the best available  
230 explanation for the relationships between the East Asian group  
and ATU 333 and ATU 123, questions remain about how, where and  
when the latter two tale types were adopted and combined. Based  
on the similarities described above, it seems likely to have occurred  
sometime between the origin of the lineage leading to Little Red  
235 Riding Hood and The Story of Grandmother, but before the publication  
of Perrault's classic tale in 1697. Shortly after this, Huang  
Zhiyun published the first known version of The Tiger Grandmother  
[52], which shares elements in common with The Story of Grandmother  
(such as the "toilet excuse" to escape the villain), but lacks any  
240 of the features specifically associated with Little Red Riding Hood  
(e.g. the girl with the red hood, her being devoured by the villain,  
etc.), suggesting he is unlikely to have been influenced by Perrault.  
Given the antiquity and wide geographic diffusion of The Wolf and  
the Kids, it is certainly plausible that ATU 123 would have also  
245 reached China by this time, perhaps between the twelfth and fourteenth  
centuries, i.e. period of east-west cultural exchanges discussed  
by Haar [51]. Given the current state of the evidence, such scenarios

are necessarily speculative. However, the digitisation and translation of an ever increasing number of folklore collections from Asia, as well as other regions, promise to yield a wealth of new data with which to investigate these questions more thoroughly in the future.

In the meantime, this case study has shown that phylogenetic methods provide powerful tools for analysing cross-cultural relationships among folktales that can be used to classify groups based on common ancestry, reconstruct their evolutionary histories, and identify patterns of contamination and hybridisation across traditions.

While these goals are clearly of crucial importance to comparative studies of folklore, they also have potentially exciting applications in other fields too. As previous researchers have pointed out, the faithful transmission of narratives over many generations and across cultural and linguistic barriers is a rich source of evidence about the kinds of information that we find memorable and motivated to pass on to others [9] [53] [54]. In the present case, stories like Little Red Riding Hood, The Tiger Grandmother and The Wolf and the Kids would seem to embody several features identified in experimental studies as important cognitive attractors in cultural evolution. These include “minimally counterintuitive concepts” (e.g. talking animals) [54], “survival relevant information” (e.g. the danger presented by predators, both literal and metaphorical; the importance of following a parent’s instructions, etc.) [9] [55],

and “social information bias” (e.g. trust, kinship relationships, deception and false belief, etc.) [56]. Phylogenetic inference and ancestral state reconstruction methods, such as those used here, provide valuable techniques for investigating the magnitude of these

275 biases in preserving and/or distorting narratives over long periods of time using real-world data. Equally, these methods could be applied to explore how tales are influenced by cultural, rather than psychological, selection pressures. Such an analysis might address whether local modifications of different tale-types exhibit consistent

280 patterns, and see if they covary with specific ecological, political or religious variables. Future work on these questions promises to generate important insights into the evolution of oral traditions, and open new lines of communication between anthropologists, psychologists, biologists and literary scholars.