Supplementary Figures

**Supplementary Figure 1.** Phylogenetic incongruence between co-genic and non-co-genic exons, bootstrap analysis (see main text and legend to Figure 2).

The analysis shown in Figure 2 was performed using 100 bootstrap trees per exon. The Robinson-Foulds distance between co-genic exon bootstrap trees is not lower than between non co-genic exon bootstrap trees.

**Supplementary Figure 2.** Theoretical upper bound on the number of ILS-induced misleading sites.

O: outgroup. X*, Y*, Z*: ancestors to X, Y and Z, respectively, at the time of the split between the Y and Z lineage. a. Example of ancestral polymorphism generating no phylogenetic conflict (only one ancestor, Y*, carries the derived allelic state). b. Example of ancestral polymorphism generating a phylogenetic conflict (X* and Y* share the derived allelic state). c. The six possible patterns of ancestral biallelic polymorphism, and their expected prevalence, p, in the ancestral population in the worst case of two simultaneous splits, i.e., $T_1 = T_2$, assuming panmixy. $\theta$ is $4N_e\mu$, where $N_e$ is the ancestral effective population size and $\mu$ the per site mutation rate (from Wright 1938). The two patterns generating a phylogenetic conflict – that is, gene tree different from species tree – are marked with an asterisk. Their summed expected prevalence is $\theta/3$.

**Supplementary Figure 3.** Exon-based mammalian species trees inferred using coalescent-aware methods on 5299 mammalian exon trees (see main text and legend to Figure 1).

Left: the ASTRAL species tree for the unmodified sources trees; Centre: the ASTRAL species tree for the source trees where edges with bootstrap value lower than 99% have been collapsed; Right: the MP-EST species tree for the unmodified sources trees. Symbols and colors: see main text, Supplementary Table 1 and legend to Figure 1.
Robinson–Foulds distance

Data sets

D1  D2  D3  D4  D5
a.

\[ \begin{align*}
T_1 & \quad - \quad - \quad - \\
T_2 & \quad - \quad - \quad - \\
X & \quad Y & \quad Z^* \\
\end{align*} \]

b.

\[ \begin{align*}
T_1 & \quad - \quad - \quad - \\
T_2 & \quad - \quad - \quad - \\
X^* & \quad Y^* & \quad Z^* \\
\end{align*} \]

c.

\[
\begin{array}{cccccccc}
O & \quad & \quad & \quad & \quad & \quad & \quad & \quad \\
X^* & \quad & \quad & \quad & \quad & \quad & \quad & \quad \\
Y^* & \quad & \quad & \quad & \quad & \quad & \quad & \quad \\
Z^* & \quad & \quad & \quad & \quad & \quad & \quad & \quad \\
p & \frac{\theta}{3} & \frac{\theta}{3} & \frac{\theta}{3} & \frac{\theta}{6} & \frac{\theta}{6} & \frac{\theta}{6} \\
\end{array}
\]