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Evolutionary aspects of atromentin synthesis genes in Agaricomycetes

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Atromentin synthesis plays a central role in the secondary metabolism of many mushroom forming fungi, since atromentin is the precursor for many other secondary metabolites such as involutin. Many of the metabolites produced by atromentin have diverse functions such as participation in litter or wood decomposition through non-enzymatic mechanisms (e.g. Fenton reaction). It has been shown that at least two genes participate in atromentin synthesis including an aminotransferase (*atrD*) and an atromentin synthase (*atrA*), which is a non-ribosomal peptide synthase. We examined the presence of homologs from the two genes across published Agaricomycete genomes, their placement on those genomes and the phylogenetic relationships of the homologs for each gene respectively. Our results suggest that *atrD* homologs belong in a large aminotransferase gene family, but closely related *atrD* homologs are widespread mostly in Boletales and Polyporales. On the other hand, *atrA* is restricted in the Boletales, where is found in multiple copies and the distantly related agaric *Omphalotus olearius*. The distribution of *atrA* and *atrD* homologs on the genomes, shows that for all species most frequently one *atrA* homolog is in close proximity with one of the *atrD* homologs present on the genomes, suggesting that synteny for the two genes is at least partly preserved. The placement of *atrA* and *atrD* homologs from *O. olearius* on the corresponding phylogenies suggests that the presence of *atrA* and *atrD* in close proximity on the genome predates the diversification of Boletales. We have also detected a third gene that is always found in the vicinity of *atrA* and *atrD*, only when the two genes are found in the same genomic area. The gene is restricted in Boletales, *O. olearius* and *Piloderma croceum*, its closest homologs are found in Bacteria and encodes a potential quinone oxidoreductase, suggesting a possible recruitment of the enzyme in a function related to atromentin synthesis or subsequent metabolic steps.