

Dating the diversification of the major lineages of Ascomycota (Fungi)

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Objetives

Establishing the dates for the origin and main diversification events in the phylogeny of Ascomycota is among the most crucial remaining goals in understanding the evolution of Fungi. There have been several analyses of divergence times in the fungal tree of life in the last two decades, but most have yielded contrasting results for the origin of the major lineages. The aim of this study is to date the main diversification events within Ascomycota.

Material and Methods

We performed a phylogenetic analyses with a total of 118 species belonging to 10 classes of Pezizomycotina and three members of Saccharomycotina and Taphrinomycotina as the outgroup. Six *loci* were used for this analysis (nuLSU and nuSSU rDNA, the 5.8S nuclear rDNA, mtSSU rDNA, and the nuclear protein-coding genes RPB1, and MCM7) with a total of 4112 characters included. We implemented a Bayesian Markov chain Monte Carlo algorithm for estimating divergence times using data from multiple gene loci and accommodating multiple fossil calibration nodes. To provide an empirical test for the impact of various approaches to calibration, we investigated four different scenarios using several combinations of fossil constraints.

Results

Our various 'relaxed clock' scenarios suggest that the origin and diversification of the Pezizomycotina occurred in the Cambrian. The earliest splits within Pezizomycotina took place in the Ordovician, resulting in the Orbiliomycetes and the Pezizomycotina crown group; in the Silurian, *resulting* in the Pezizomycetes and the "Leotiomyces"; and in the Upper Devonian giving rise to the Geoglossomycetes. The main lineages of lichen-forming Ascomycota originated at least as early as the Carboniferous, with successive radiations in the Jurassic and Cretaceous generating the diversity of the main modern groups.

Conclusions

We provide estimates for the origin and diversification dates for many clades in the Pezizomycotina, which previously had not been dated, including the current major classes and orders, as well as some families of both lichenized and non-lichenized groups. Such dates, even if tentative, set a promising foundation for future hypotheses on the evolution of this fascinating group of Fungi.