CONIFER REPRODUCTIVE BIOLOGY EVOLUTIONARY PATHWAYS

The intent of this talk was to provide a baseline for conifer reproductive biology from its early beginnings to the current diversity found among north-temperate conifers. I consider it a work in progress. Time estimates of significant events are primarily based on fossil evidence and are therefore restricted to samples which have been 'fossilized' under appropriate conditions and have been found. Land plants appeared approximately 450 million years ago (MYA) and coincided with the appearance of mycorrhizal associations. These early land plants reproduced like ferns and were dependent on water for spore dissemination. Xylem evolution preceded seeds and this allowed plants to reduce potential for embolism under freezing or drought conditions, in addition to significant height increases and an increased competitive ability for sunlight.

The evolution of seeds is generally considered in terms of three large-scale evolutionary changes:
1) Heterospory – The differentiation of two separate spore types differing in size and sex. Considered to have occurred multiple times in plant evolution.
2) Megaspore Reduction / Retention in Sporophyte – The reduction to one female sprore (megaspore) from many and maintenance of the structure within the body of the parent plant (endospory).
3) Integument Evolution – The evolution of protective tissues to protect the innermost structures.

In conifers, a variety of pollen reception mechanisms evolved and these finalized the conversion to the water independence of spores for movement and fertilization. Seeds, in addition to mycorrhiza and xylem, are considered the major evolutionary factors allowing conifers to dominate large land areas, especially those with stressful or sub-optimal environments. Seeds can be thought of as "concentrated life" as the seed contains the future diploid tree, the initial food reserves, and the seed coat for protection. Seeds are the dispersal package and they also 'allowed' for the development of seed dormancy to synchronize germination with the appropriate environmental conditions to maximize survival and growth.

The two main groups of seed plants, Angiosperms (about 250,000 species) and Gymnosperms (600−700 species) diverged approximately 310 MYA. Inverted ovules, pointing towards the central axis, is a characteristic of most conifers and evolved approximately 265 MYA. The inverted ovules' orientation (up or downwards pointing) is related to the type of pollen present (saccate or non-saccate). Subsequent to ovule inversion there was also a division of the Pangeaen supercontinent about 200 MYA resulting in species isolation and evolution of some highly variable reproductive biology mechanisms among conifers. One third of all conifers are attributed to two genera: *Pinus* in the Northern hemisphere and *Podocarpus* in the Southern hemisphere.

Conifer cones are basically structures that house ovules, allow for pollen to enter, and then close to protect the embryo. In many species this is a woody structure, but *Taxus* and *Podacarpus* are examples of conifer genera with fleshy structures to house the seed. In general, pollen cones (microsporangia arranged spirally along a central axis) are relatively simple and each microsporangium is considered to be a modified leaf. These pollen cones do not show a great deal of diversification among genera. The seed cones (bract scale complexes arranged spirally along a central axis) are considered to be more complicated as each bract-scale complex is considered to be a modified shoot vs. a modified leaf as for pollen cones. In contract, seed cones have differentiated greatly in terms of gross morphology, ovule orientation, and type of ovular secretion mechanism.

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