In this work two novel methodologies for the photo-induced electron transfer (PET) cyclizations of polyalkene terpenoids, involving  $Cu^{2+}$ -ions, are accomplished. The first methodology allows to generate in a stepwise fashion two cationic intermediates from an  $\omega$ -double bond of terpenoid polyalkene. The mechanism of this reaction is elucidated in this thesis. The dependence on solvent, solvent proportions and temperature was also investigated. The obtained cyclic and bicyclic products are important building blocks for the synthesis of a number of natural products.

The second new methodology is the result of further improvement of Cu(II)-mediated PET-cyclizations where Cu(II)-acetate is employed as a co-oxidant together with another Cu<sup>2+</sup>-ion involved in the complex. Different chiral and achiral Cu(II)-complexes are employed as substrates in the phototransformations. The aim of this part of work was to develop a catalytic and enantioselective photochemical cyclization with further application in natural products synthesis. Based on the products and some mechanistic investigations we propose a reaction mechanism for this complex cyclization cascade. Further, substitution of one of the substrates in the complex with a chiral semicorrin ligand gives an enantiomeric excess which is low, but might be possible to be improved in the future. To clear the relatively low enantioselectivity of this reaction additional quantum mechanical calculations of the structures of the Cu(II)- and analogous Zn(II)-complexes were performed.

Another aim of the work was to analyze and possibly improve previously developed synthetic strategies toward the basic taxane skeleton and design the synthetic procedure to cyclize the precursor molecules to taxadiene bearing substituents or analogs thereof such as verticillene or cembrene. Thus the new, efficient and cheap approach toward the basic taxane skeleton was developed as a result of this work. Additional quantum mechanical calculations were performed to elucidate preferred conformations of the potential precursors. It was shown that the variations on the substituents makes possible to inhibit sterically the sterol-like prefolding and favour non-folded conformations of precursors (taxane-like pre-folding).