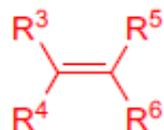


PAUSON-KHAND REACTION

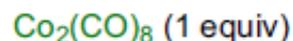
Pauson & Khand (1973):



+

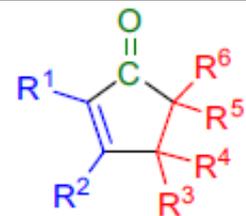


mono-, di- or
trisubstituted alkene



solvent / heat

$R^1 > R^2$



Substituted cyclopentenone

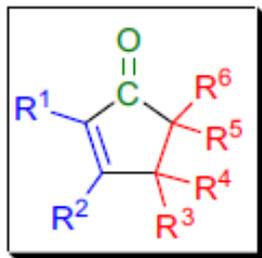
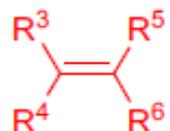
terminal or internal
alkyne

Modified P-K reaction:

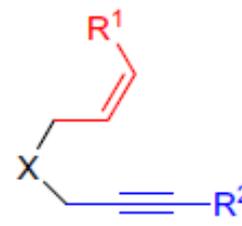


transition metal
complex
(1 equiv)

promoter / solvent
CO atmosphere

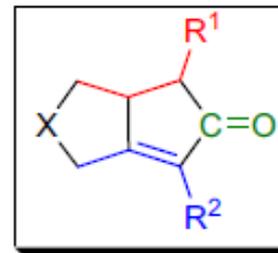


Intramolecular variant:

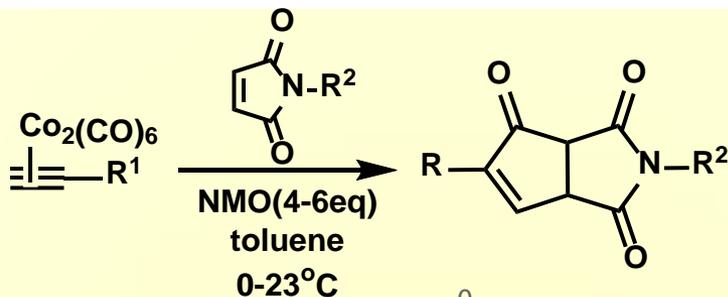


$\text{Co}_2(\text{CO})_8$
(1 equiv)

promoter / solvent
X = CH₂, CHR,
CR₂, O, NHR, S



R^{1-6} = H, alkyl, aryl, substituted alkyl and aryl; transition metal complex: $\text{Co}_2(\text{CO})_8$, $\text{Fe}(\text{CO})_5$, $\text{Ru}_2(\text{CO})_{12}$, Cp_2TiR_2 , $\text{Ni}(\text{COD})_2$, $\text{W}(\text{CO})_6$, $\text{Mo}(\text{CO})_6$, $[\text{RhCl}(\text{CO})_2]_2$; promoter: NMO, TMAO, RSCH_3 , high-intensity light/photolysis, "hard" Lewis base



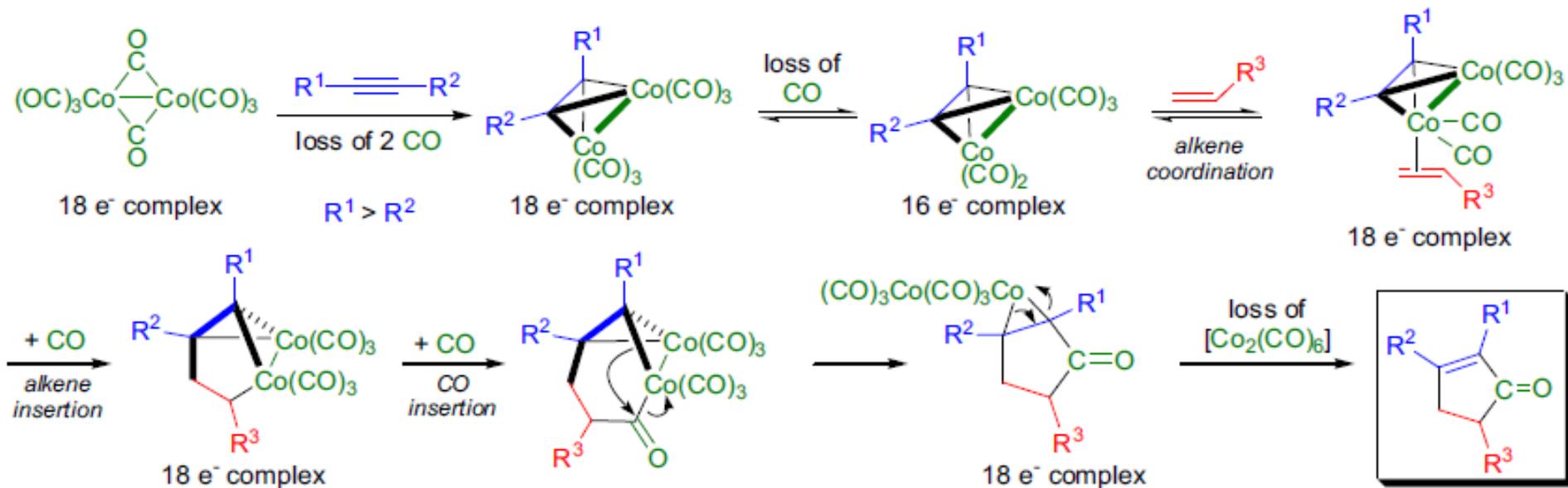
Features

- 1 the reaction is feasible both inter- and intramolecularly;
- 2 acetylene and terminal as well as internal alkynes are all substrates for the reaction. However, **derivatives of propynoic acid do not react**;
- 3 the required alkyne-cobalt complexes are easily prepared by reacting alkynes with dicobalt octacarbonyl;
- 4 internal alkynes tend to give lower yields of the product than terminal alkynes;
- 5 a wide range of alkenes are feasible reaction partners and, generally, strained cyclic alkenes react the fastest;
- 6 the order of reactivity is significantly influenced by the substitution pattern of the alkene substrate: strained cyclic alkene > terminal alkene > disubstituted alkene >> trisubstituted alkene, and **tetrasubstituted alkenes do not react**;
- 7 alkenes with strongly electron-withdrawing groups give poor or no reaction;
- 8 the reaction is highly regioselective: the larger alkyne substituent (R1) ends up next to the carbonyl group in the product, but the regioselectivity with respect to the alkene is less predictable in intermolecular reactions;
- 9 with cyclic alkenes the reaction is highly stereoselective and the *exo* product is formed preferentially;

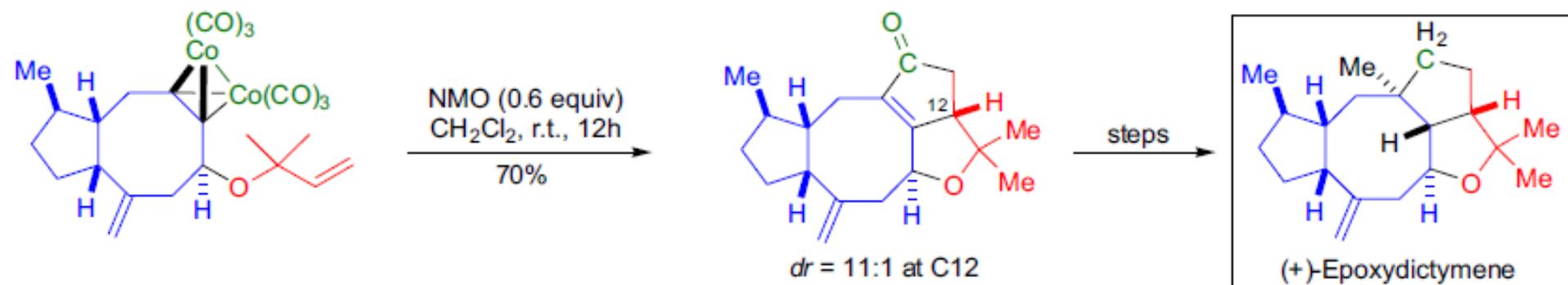
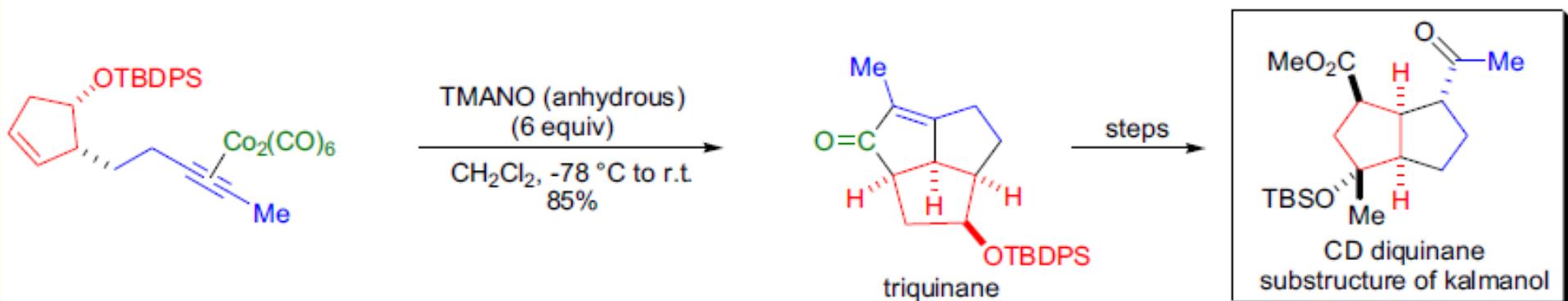
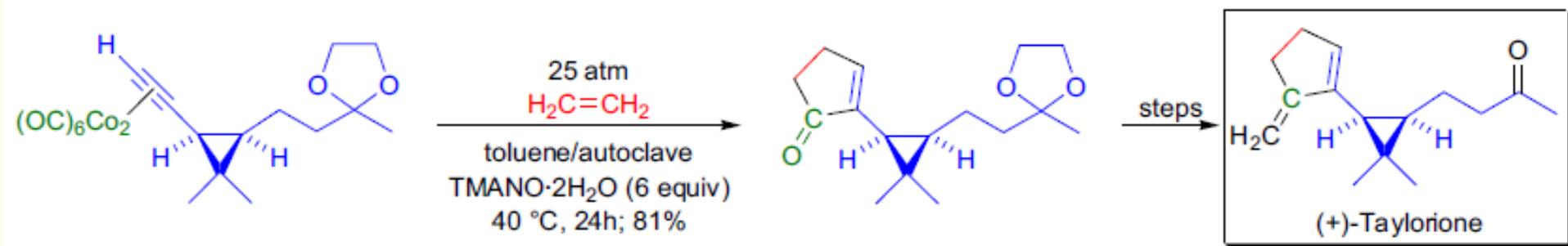
Features

- 10 intramolecular reactions proceed with excellent regio- and stereoselectivity;
- 11 with the use of chiral auxiliaries the reaction conditions are compatible with a large number of different functional groups. However there are certain functionalities that are only partially tolerated: alkyl and aryl halides, vinyl ethers, and vinyl esters;
- 12 the reaction can be accelerated by the addition of various promoters (such as tertiary amine oxides, high-intensity light, etc.), which help to open a coordination site at one of the cobalt atoms for the alkene to coordinate;
- 13 it is possible to run the cyclization catalytically but only in the presence of a high pressure atmosphere of CO;
- 14 besides $\text{Co}_2(\text{CO})_8$, other transition metal complexes also efficiently catalyze the cyclization (e.g. $\text{Fe}(\text{CO})_5$, $\text{Ru}_2(\text{CO})_{12}$, etc.)

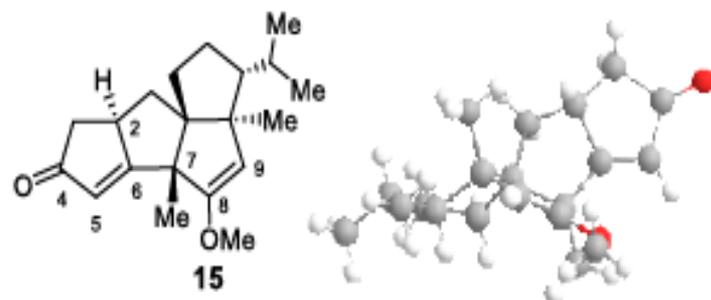
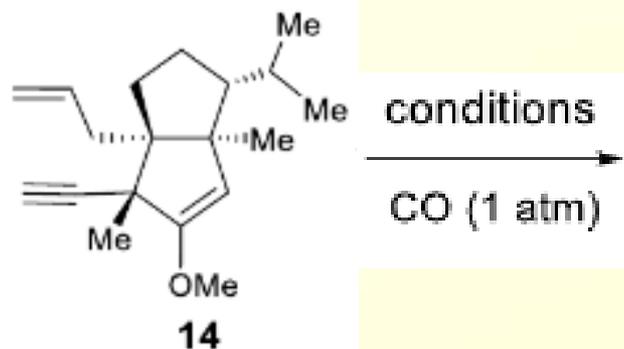
Mechanism



Applications



Applications



a, DMDO, Na₂HPO₄ (aq) b. H₂O₂, NaHCO₃

