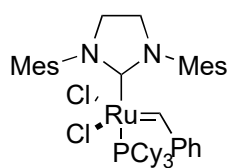
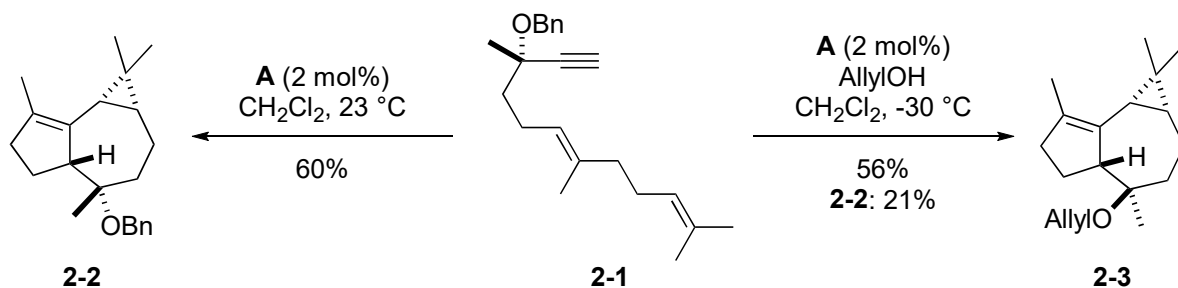
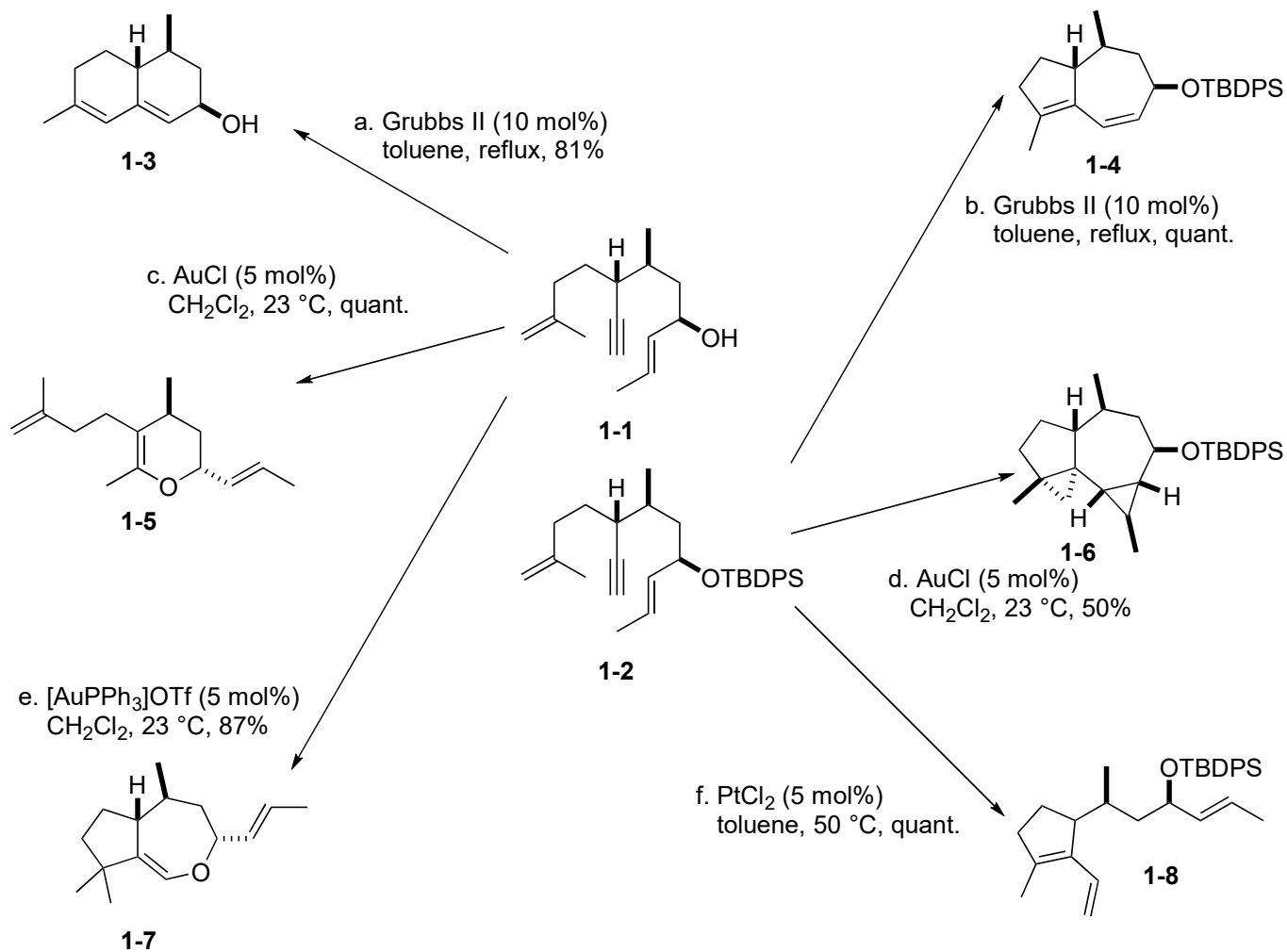


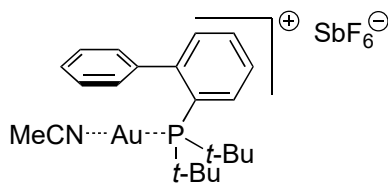
Problem Session (5) - Problem

2020.5.30 Yusuke Imamura

Please explain the reaction mechanisms.



Grubbs II



A

Problem Session (5) - Answer

Topic: Enyne cycloisomerization

0. introduction

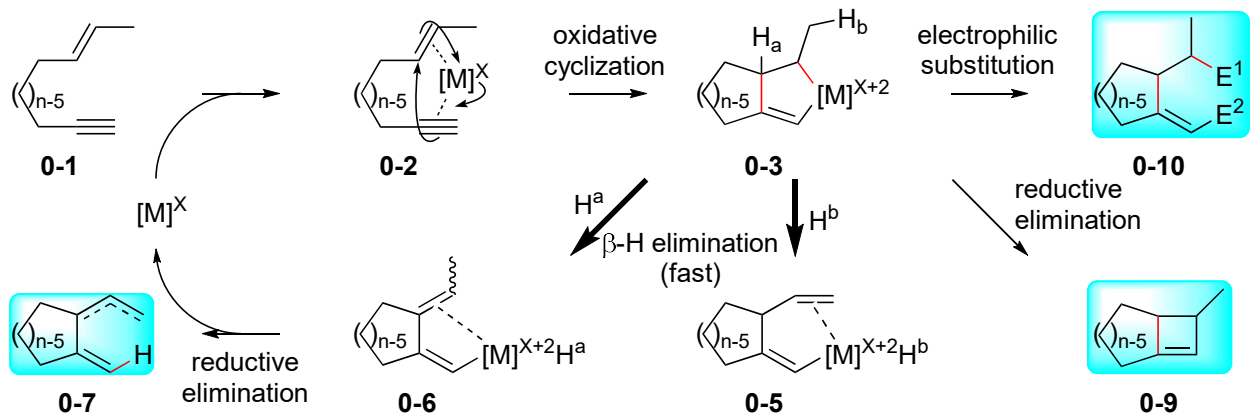
0.1. mode of reaction

0.1.1. oxidative cyclometalation mechanism

originally Pd^{II}-Pd^{IV}-Pd^{II} cycle

Almost every transition metals Pd, Ru, Rh, Ir, Co, Ti, etc are reported.

with coordinatively saturated metals

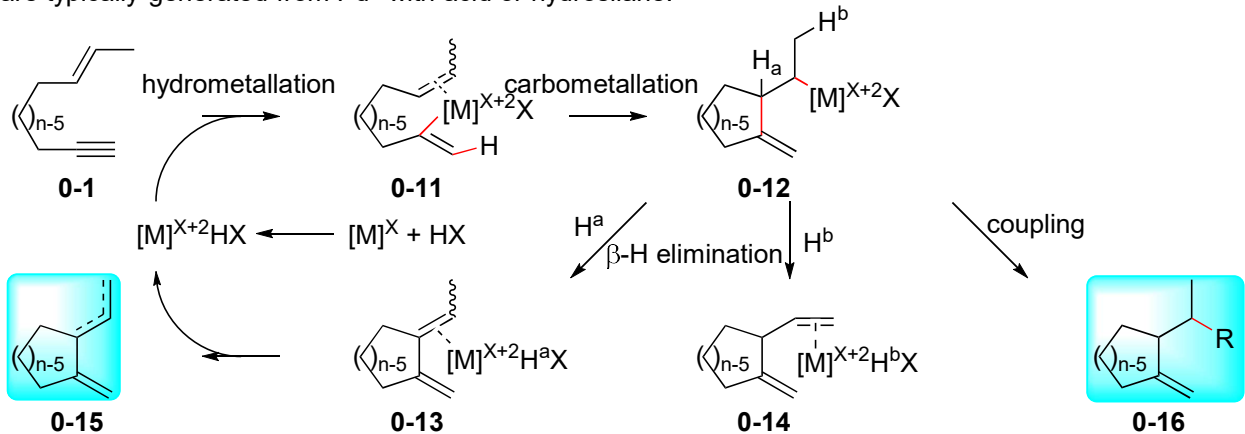


0.1.2. vinyl metal mechanism (metal hydride mechanism)

no change in oxidation state of metal catalyst

Pd, Ni, Rh are typically used.

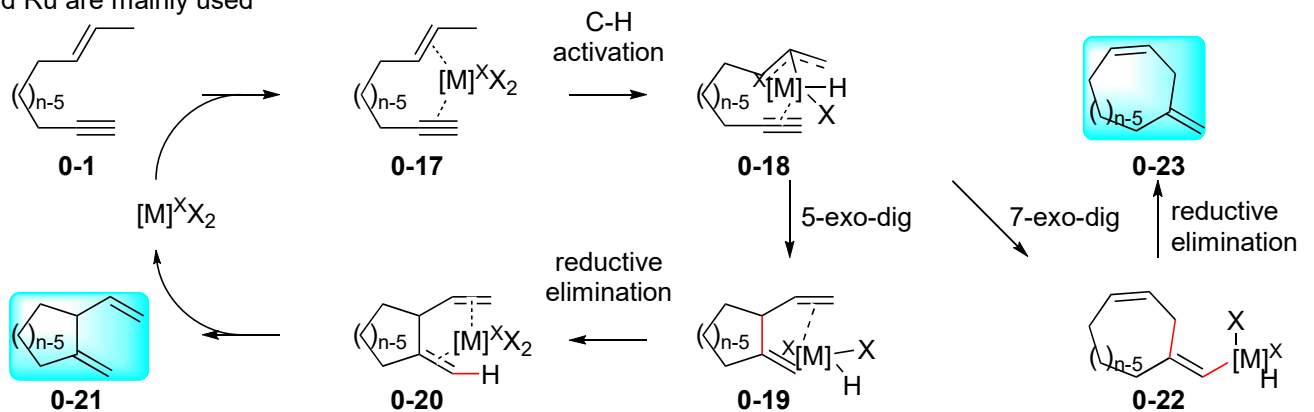
Pd-H are typically generated from Pd⁰ with acid or hydrosilane.



0.1.3. π-allyl metal complex mechanism

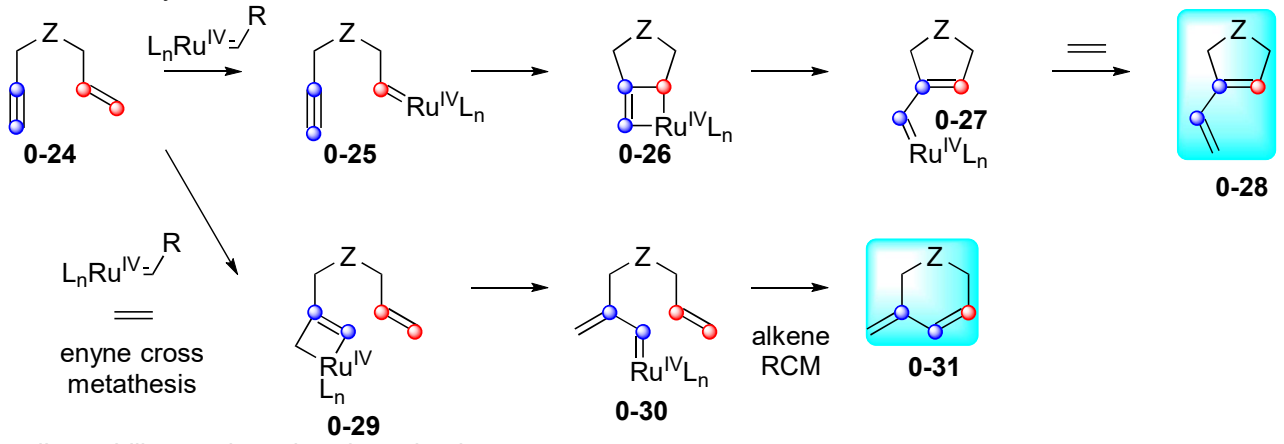
rare type

Pd and Ru are mainly used

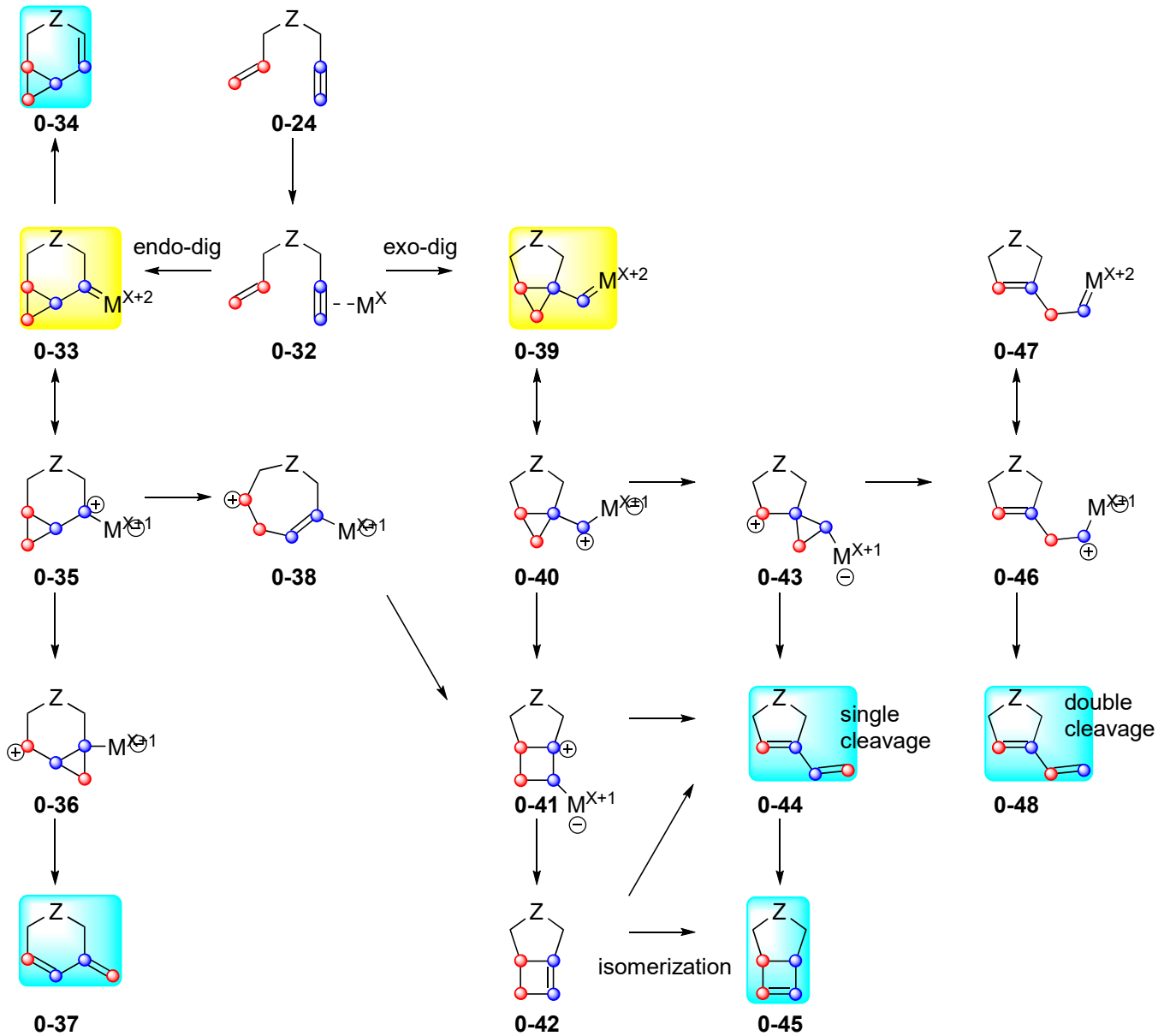


0.1.4. metathesis mechanism
Ru are most widely used

ring-closing enyne metathesis

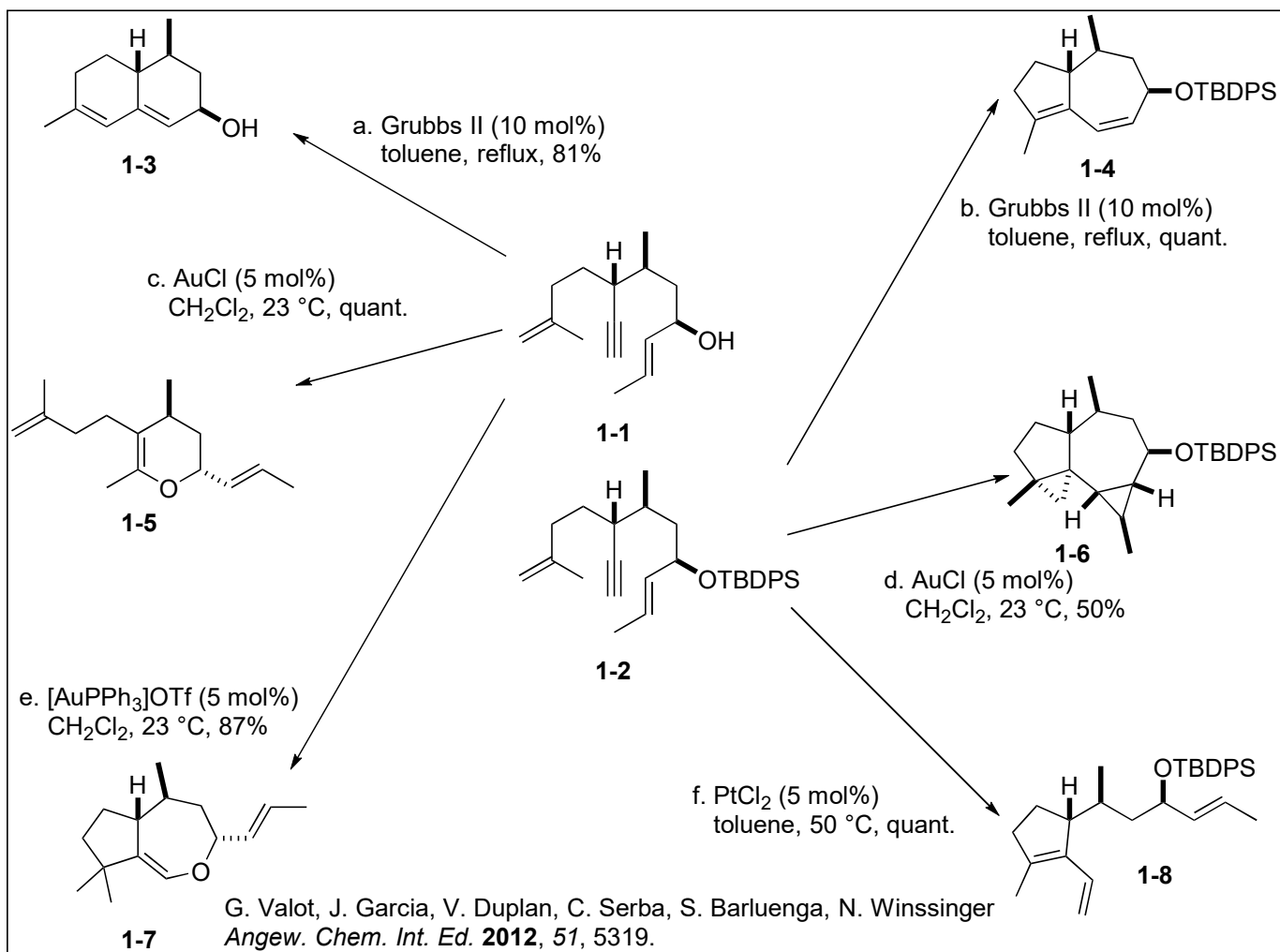


0.1.5. alkynophilic metal-catalyzed mechanism
alkynophilic metal centers were used
(Au, Pt, Ag, Cu, Hg etc...)



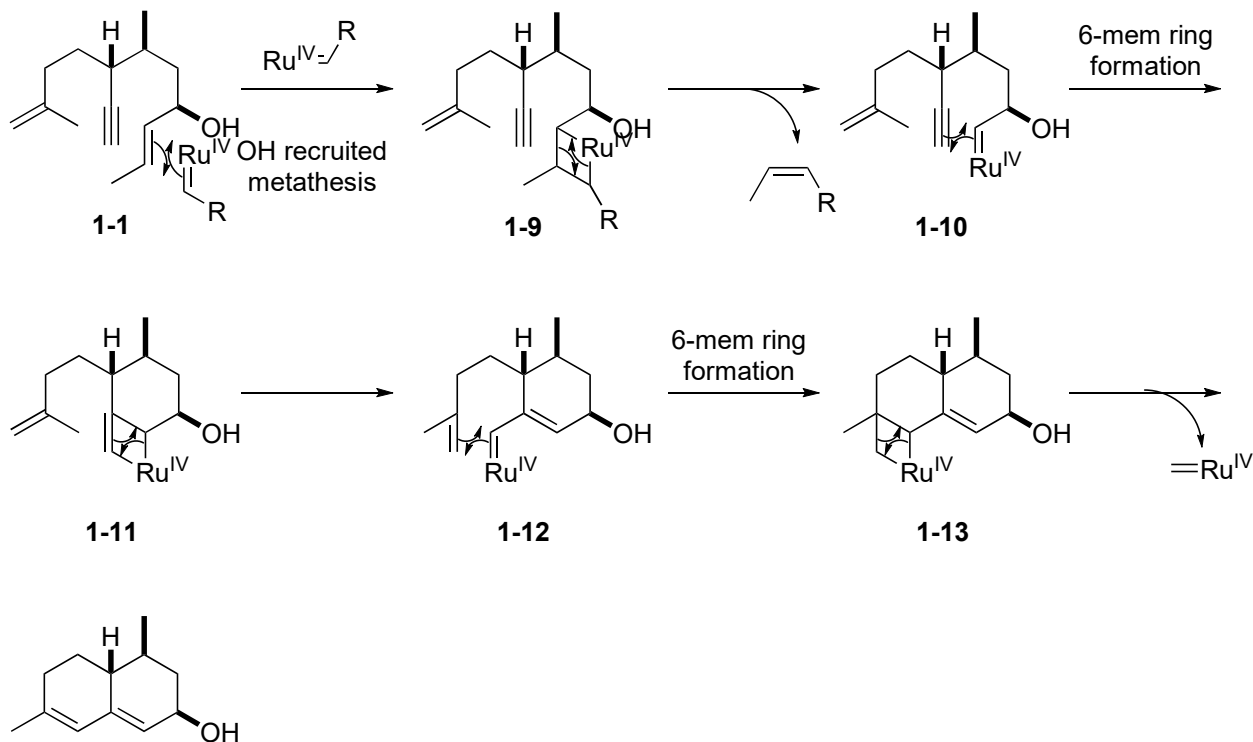
1. Divergent reactivity of enyne with various metals

1.1. Problem

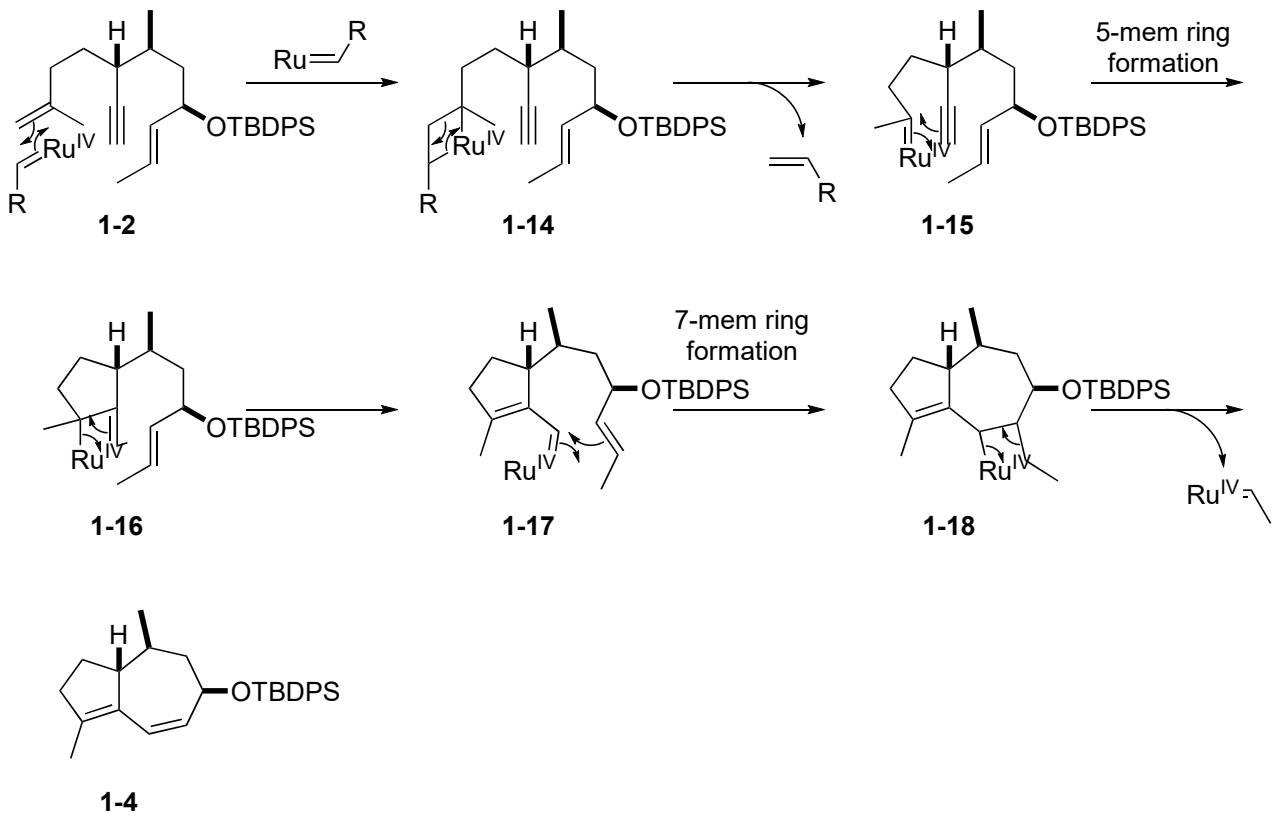


1.2. Answer

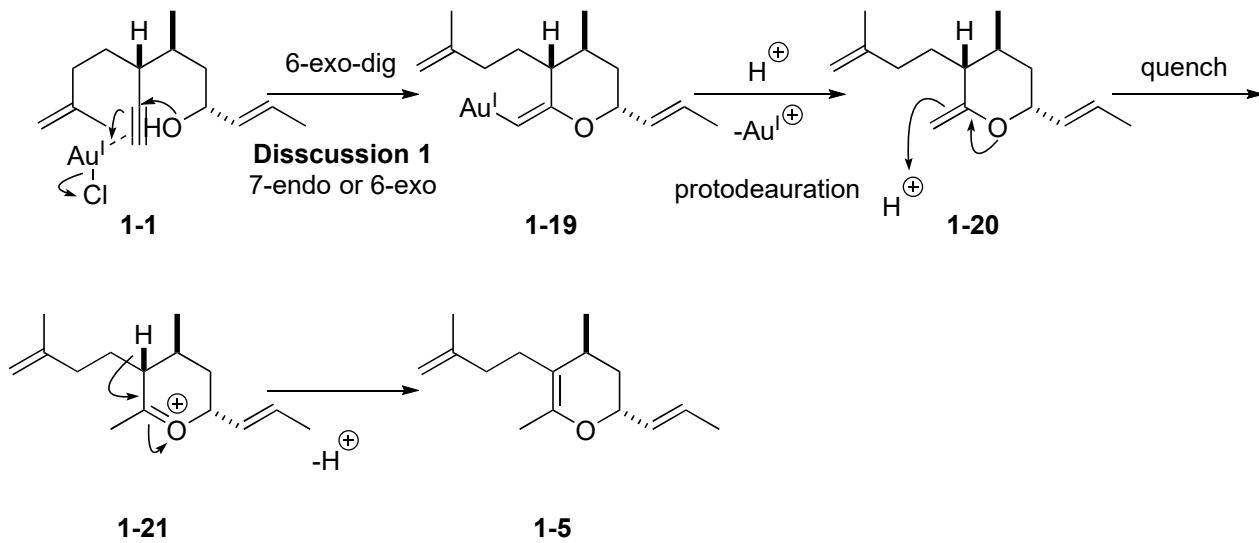
1.2.1. conditions a (unprotected, Grubbs II)



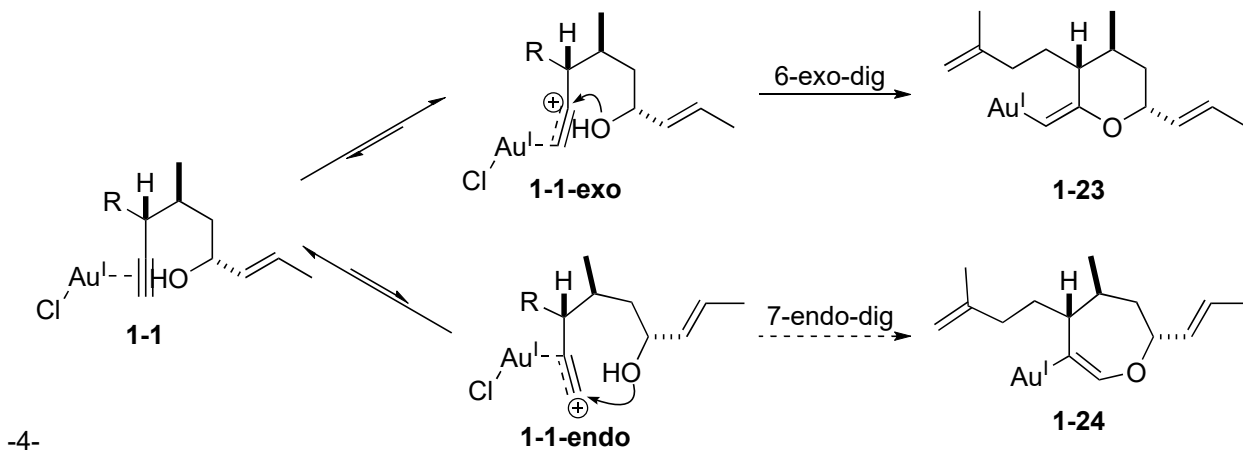
1.2.2. conditions b (protected, Grubbs II)



1.2.3. conditions c (unprotected, AuCl)

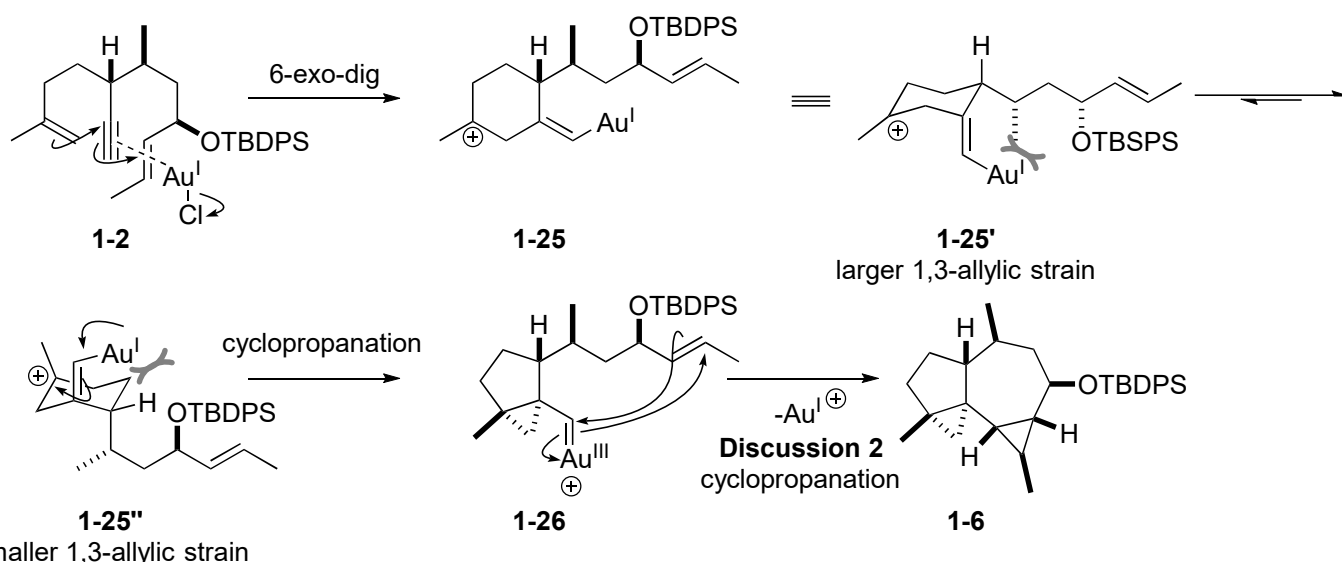


Discussion 1 selectivity of cyclization



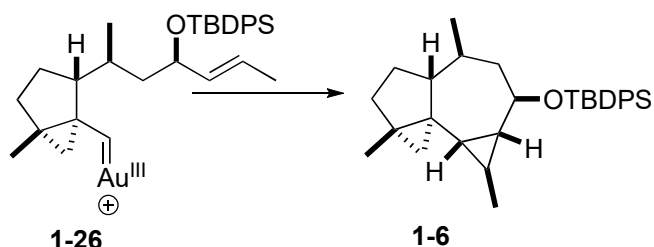
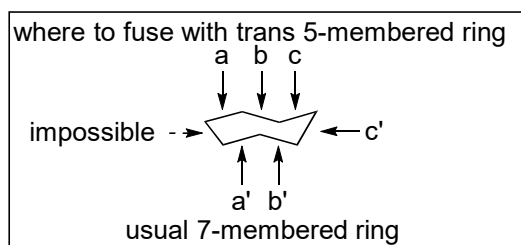
more substituted cation was stable (Markovnikov's rule)

1.2.4. conditions d (protected, AuCl)



Discussion 2: diastereoselectivity of cyclopropanation

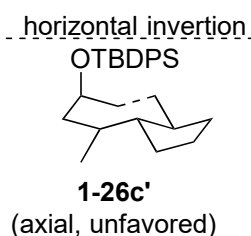
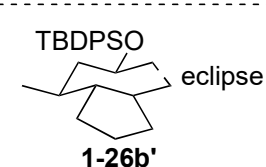
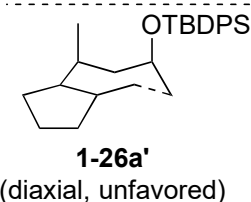
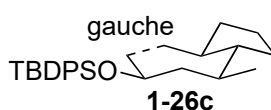
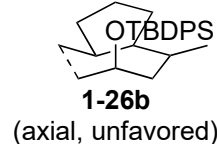
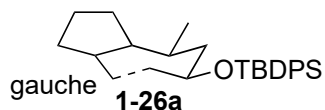
Possible conformation of 5/7 trans fused ring are considered to rationalize the selectivity.



fused with bond a

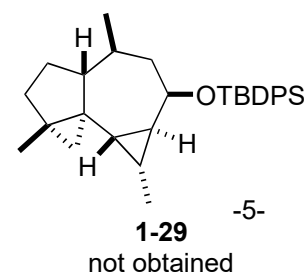
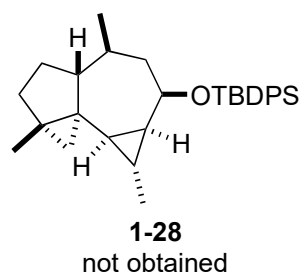
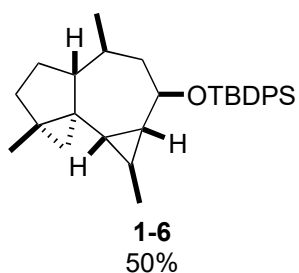
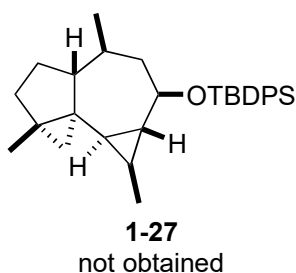
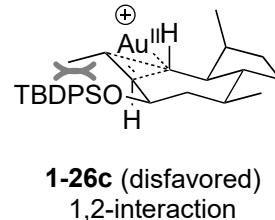
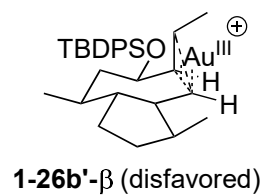
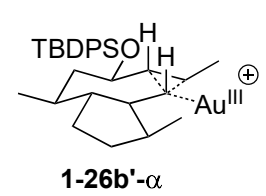
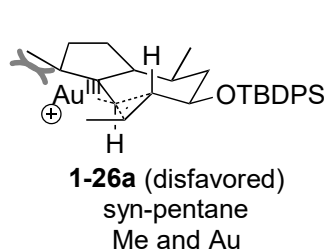
fused with bond b
(vertically inverted)

fused with bond c

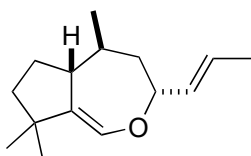
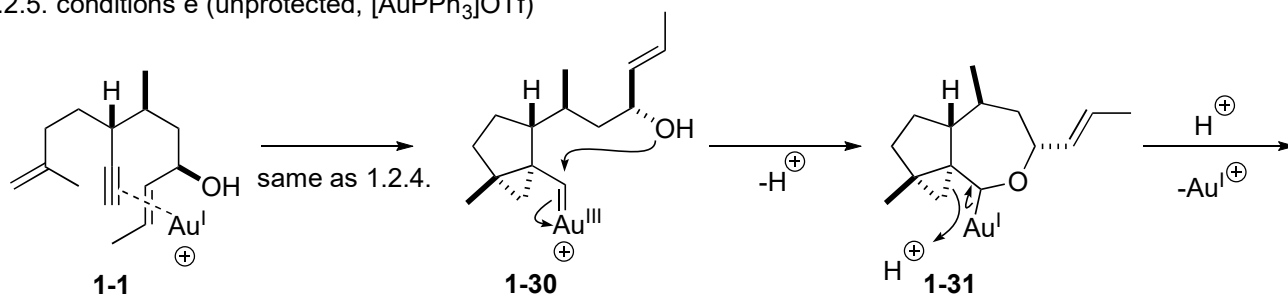


Some functionalities were omitted for clarity.

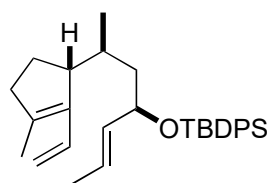
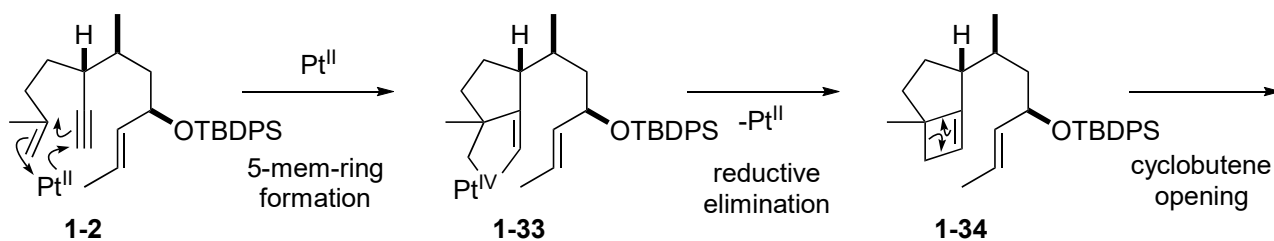
cyclopropane was omitted.



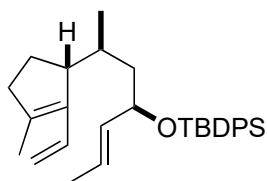
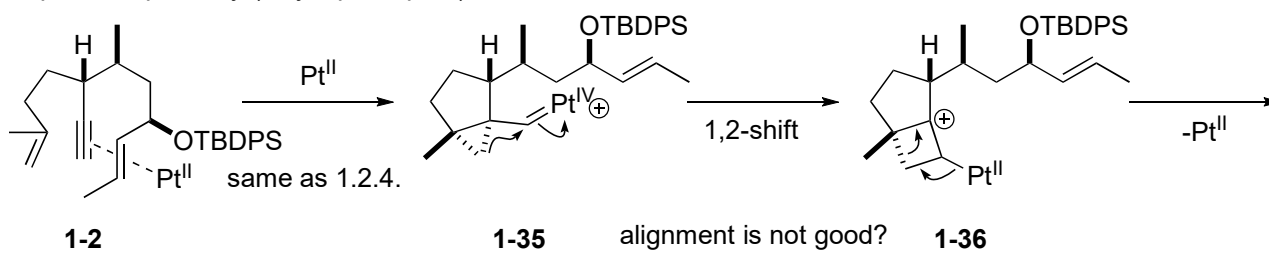
1.2.5. conditions e (unprotected, $[\text{AuPPh}_3]\text{OTf}$)



1.2.6. conditions f (protected, PtCl_2)

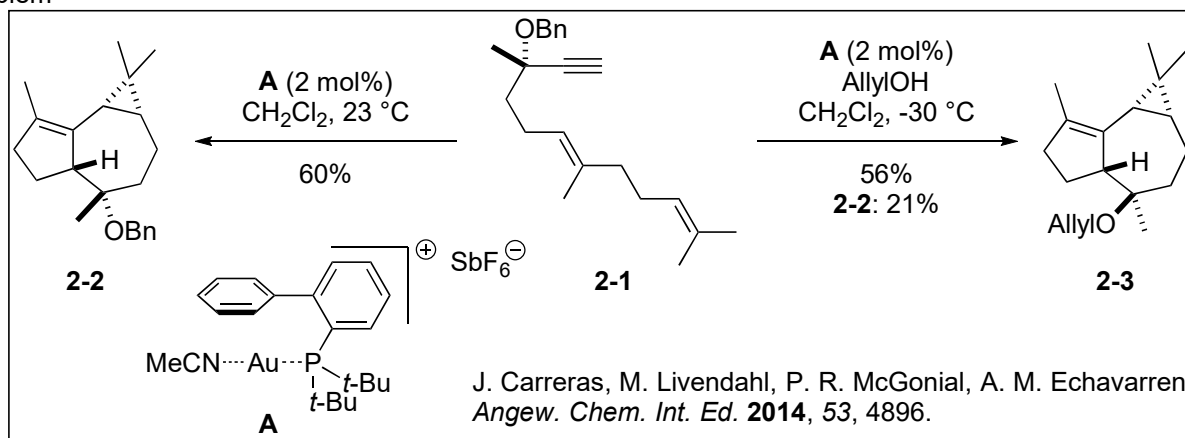


another possible pathway (alkynophilic path)

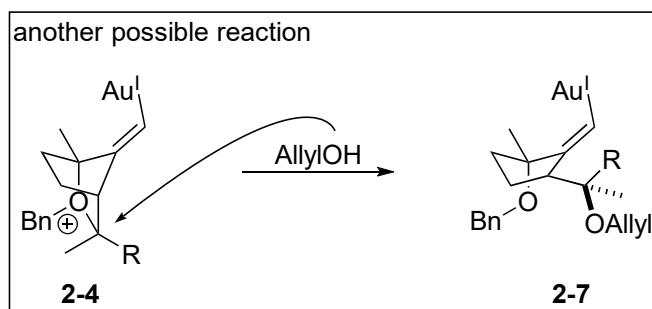
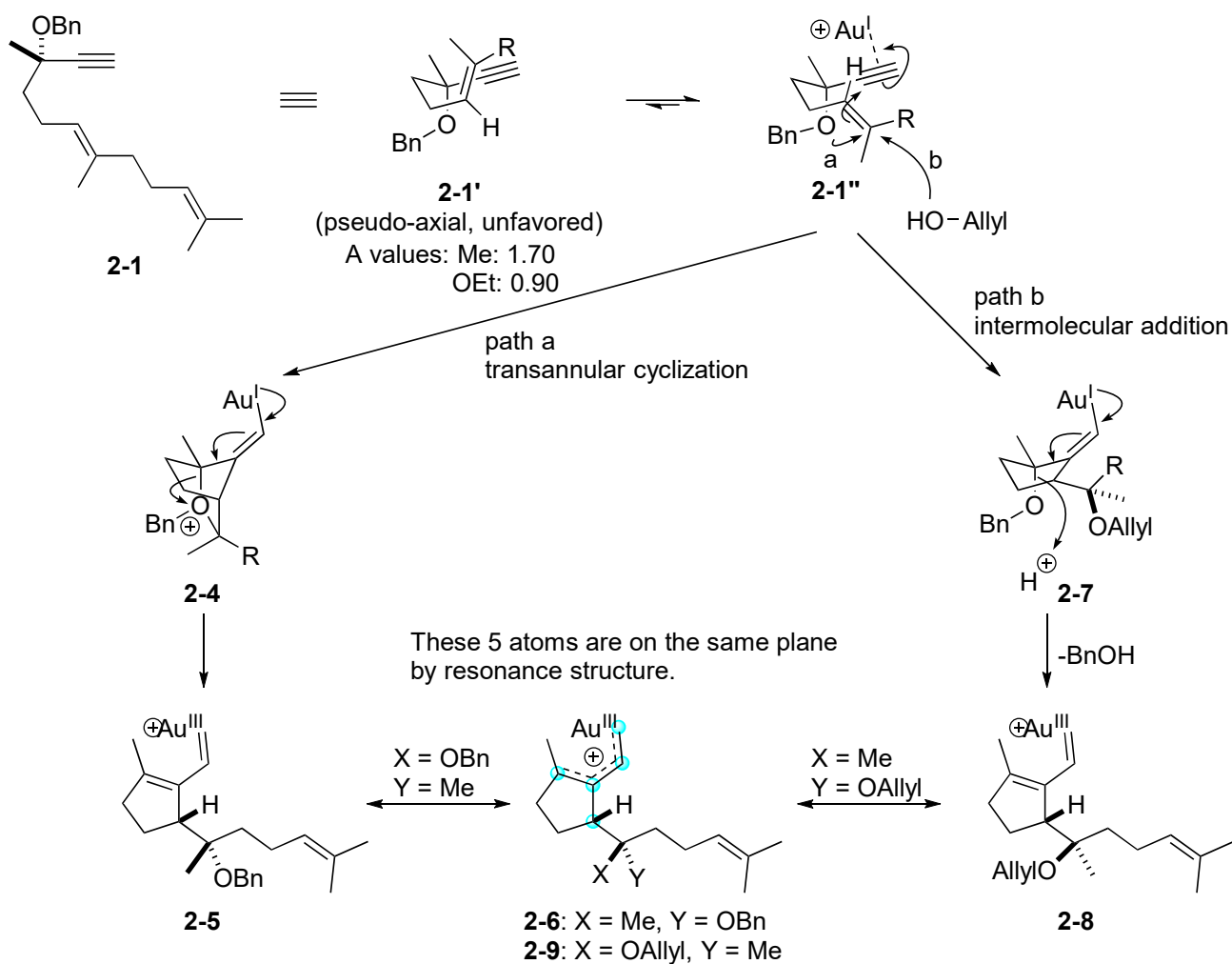


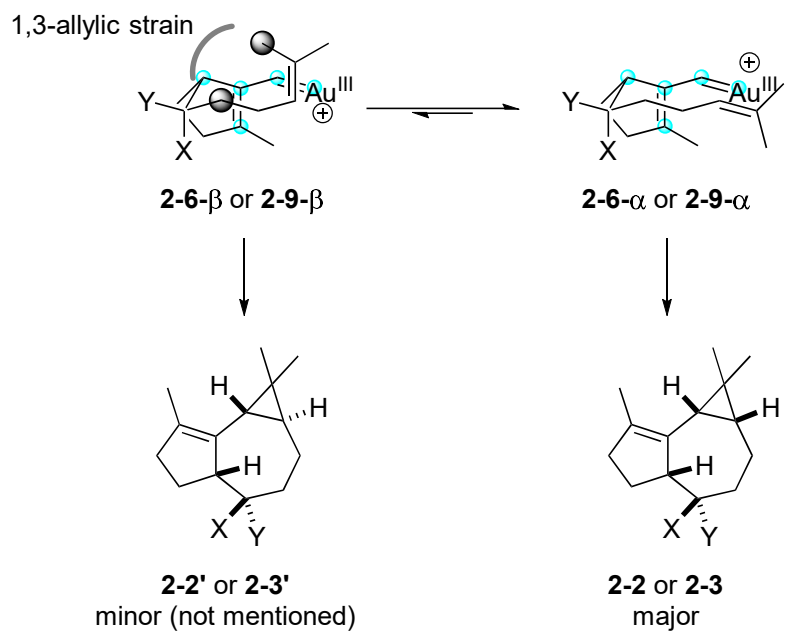
2. stereodivergent synthesis of aromadendrane sesquiterpenes

2.1. problem



2.2. answer





Appendix

Wood, J. L.; Liverton, N. J.; Visnik, M.; Smith III, A. B. *J. Am. Chem. Soc.* **1989**, *111*, 4530.

"Difference in heat of formation for the trans- and cis-bicyclo[5.1.0]octanes are 12 ± 1 kcal/mol."