Tetrahedron Letters,Vol.27,No.20,pp 2223-2226,1986 0040-4039/86 $3.00 + .00
Printed in Great Britain Pergamon Journals Ltd.

THE PALLADIUM (II) ACETATE PROMOTED 6-ENDO-TRIG CYCLIZATION OF 1,1-DIALKYL-2-SILYLOXY-1,5-DIENES.[1]

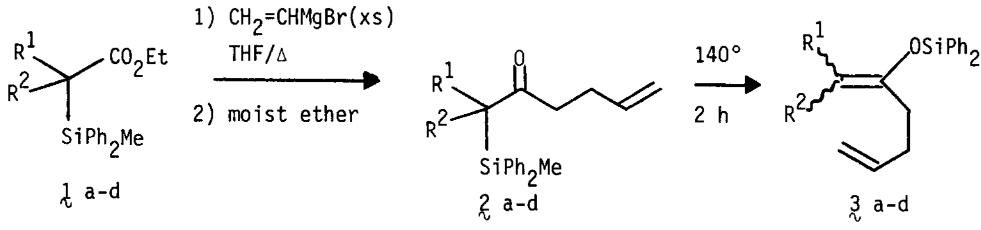
Luz E. Torres[2] and Gerald L. Larson*

Department of Chemistry, University of Puerto Rico, Rio Piedras, PR 00931

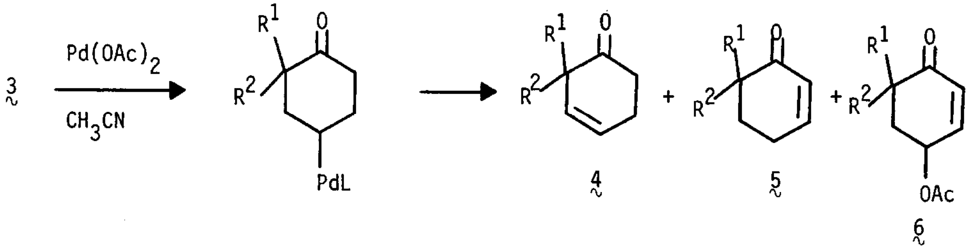
Summary: A route to cyclohexenones via the treatment of selected γ,δ-unsaturated enol silyl ethers with palladium (II) acetate is presented.

The reaction of enol silyl ethers with palladium (II) acetate was initially shown to provide an excellent route to conjugated enones.[3] The reaction was subsequently demonstrated to be useful for the preparation of cycloalkenones providing the enol silyl ether is suitably unsaturated. This cyclization procedure has been particularly successful in the 5-exo-trig cyclization of 2-silyloxy-1,5-pentadienes, to provide cyclopentenones[4,5], bridged and spirocyclic bicycloalkenones[6] and more recently has been applied to methyl enol ethers[7]. This useful cyclization has also been studied mechanistically.[8]

We wish to report herein that the cyclization of 1,1-dialkyl-2-(methyldiphenylsilyloxy)-1,5-dienes, formed according to eq 1,[9] do not cyclize to give cyclopentenones upon treatment with palladium (II) acetate, but rather undergo a 6-endo-trig process.(eq 2)[10] As can be seen from the results given in the Table, all of the systems studied, with the exception of **3f** (eq 3) give the six-membered ring products to the exclusion of the cyclopentenones. Although the mechanistic details are far from resolved at this time[11], the results in hand are consistent with initial complexation of the palladium with the terminal double bond followed by cyclization to the 6-endo-trig product presumably due to steric effects. Elimination of palladium hydride from the resulting alkyl palladium intermediate provides the observed **4** and the conjugated cyclohexenone **5** as a result of isomerization of the initially formed β,γ-cyclohexenone.



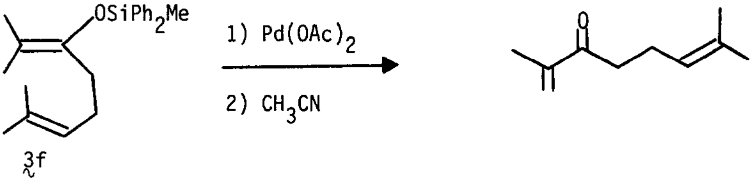
(1)



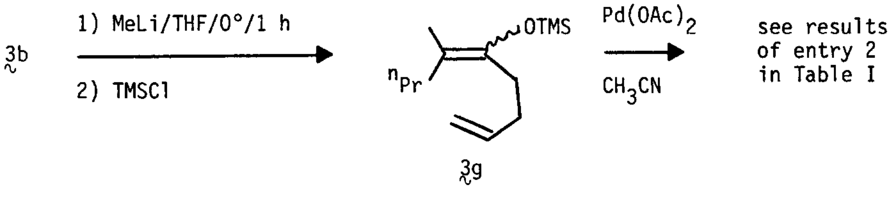
(2)

The intriguing formation of the 4-acetoxycyclohex-2-en-1-one is speculatively proposed as arising from nucleophilic attack of acetate on a π-allyl palladium complex perhaps formed from the conjugated cyclohexenone. This is consistent with the fact that its production increases with increasing reaction time. When the olefin is sterically crowded as with **3f** only the enone **7** is formed as a result of complexation of the palladium at the enol silyl ether double bond.(eq 3)[3] This class of acyclic enone product was not observed in any of the other reactions.

The palladium (II) acetate-promoted cyclization of **3g**, prepared according to eq 4, gave the same products as **3b**, in a similar ratio. This indicates that the nature of the silicon in the enol silyl ether has little to do with the cyclization under discussion.



(3)



(4)

Representative Procedure

To a stirring solution of 0.38 g (1.7 mmol) of palladium (II) acetate in 8 mL of acetonitrile was added 0.59 g (1.7 mmol) of **3b** at room temperature. The resulting reaction mixture was stirred at that temperature for 24 h monitoring the progress by TLC (silica gel-hexane). Upon completion, the reaction mixture was diluted with acetonitrile (10 mL) and filtered to remove the precipitated palladium black. The products were separated by flash chromatography eluting with ethyl acetate:hexane (2:98 v/v).

TABLE I: Cyclization of 1,1-Dialkyl-2-silyloxy-1,5-dienes.

Entry	Silyl Enol Ether[a]				% 4 + 5[b]	% 6[b,c]	% Yield[d]
		R^1	R^2	R^3			
1	**3a**	Me	Me	H	60	13	73
2	**3b**	Me	^{n}Pr	H	47	18	65
3	**3c**	Me	allyl	H	35	10	45
4	**3d**	Me	^{n}octyl	H	44	12	56
5	**3e**[e]	Me	Me	Me	60	40	100

a. Used as a mixture of isomers (entries 2-4).

b. Characterized as the mixtures. All new compounds showed IR, NMR (^{1}H and ^{13}C), MS and analytical (C,H) data consistent with the proposed structures.

c. Yields of material isolated by flash chromatography.

d. Characterized as a mixture of diastereomers (entries 2-4).

e. Prepared by adding MeI to the reaction mixture of **1a** prior to workup. See reference 9.

ACKNOWLEDGEMENTS: We wish to thank the NIH-MBRS program (RR-8102-11), Pfizer, Inc., Squibb Manufacturing, Inc. and the University of Puerto Rico for their support of our work. We thank the NSF (CHE-79-1462) for a grant to purchase the Jeol FX90Q NMR spectrometer. Dr. Osvaldo Rosario is thanked for mass spectral analyses and Drs. Sydia Sandoval and J. Antonio Prieto for helpful discussions.

REFERENCES:

1. The chemistry of α-silyl carbonyl compounds part 13. For part 12 see J. Org. Chem. submitted for publication.
2. Minority Access to Research Careers (MARC) Fellow, 1983-1987.
3. Ito, Y.; Hirao, T.; Saegusa, T. J. Org. Chem., **1978**, 43, 1011.
4. Ito, Y.; Aoyama, H.; Hirao, T.; Mochizuki, A.; Saegusa, T. J. Am. Chem. Soc., **1979**, 101, 494.
5. Ito, Y.; Aoyama, H.; Saegusa, T. Ibid, **1980**, 102, 4519.
6. Kende, A.S.; Roth, B.; Sanfilippo, P.J. Ibid, **1982**, 104, 1784.
7. Kende, A.S.; Battista, R.A.; Sandoval, S. Tetrahedron Lett., **1984**, 25, 1341.
8. Kende, A.S.; Roth, B.; Sanfilippo, P.J.; Blacklock, T. J. Am. Chem. Soc., **1982**, 104, 5808.
9. Larson, G.L.; Montes de Lopez-Cepero, I.; Torres. L.E. Tetrahedron Lett., **1984**, 25, 1673.
10. The Pd(II) catalyzed cyclization of 2-allyl anilines has been shown to give both 5-exo-trig and 6-endo trig derived products depending on the olefin structure. Hegedus, L.S.; Allen, G.F.; Bozell, J.J.; Waterman, E.L. J. Am. Chem. Soc., **1978**, 100, 5800.
11. Further details on the mechanistic aspects and the applications of this reaction will be reported in due course.
12. Prepared from the reaction of **1a** with an excess of 2-methylpent-2-en-1-ylmagnesium bromide.

(Received in USA 3 February 1986)