Alkylation of Carbonyl Compounds with ω-Iodo-2-trimethylstannylalk-1-enes. Novel Annulation Sequences Leading to Diene Systems

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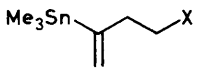
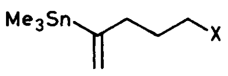
Alkylation of cyclic ketones and α-methoxycarbonyl ketones with 4-iodo-2-trimethylstannylbut-1-ene and/or 5-iodo-2-trimethylstannylpent-1-ene, and subsequent $(Ph_3P)_4Pd$-catalysed cyclization of the enol trifluoromethanesulphonates derived from the alkylation products, form the basis of new annulation sequences which result in the formation of diene systems.

Recent reports[1,2] have demonstrated the use of 4-chloro-2-trimethylstannylbut-1-ene (**1**)[1a,3] and 5-chloro-2-trimethylstannylpent-1-ene (**2**)[3] as suitable precursors of novel reagents which serve as synthetic equivalents to the donor–acceptor (d–a) synthons (A) and (B), respectively. We report herein (i) that cyclic ketones and α-methoxycarbonyl ketones can be alkylated conveniently with the iodides (**3**) and/or (**4**), and (ii) that the enol trifluoromethanesulphonates of the corresponding alkylated materials can be cyclized efficiently in the presence of a catalytic amount of $(Ph_3P)_4Pd$ to afford diene systems with positionally defined carbon–carbon double bonds. Overall, the resulting novel annulation reactions can be represented in general terms by the conversion (C) → (D).



(1) X = Cl
(3) X = I



(2) X = Cl
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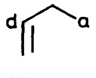
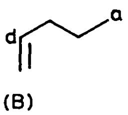
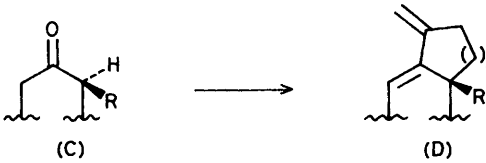


(A)



(B)



(C) (D)

Alkylation [Pr^i_2NLi, tetrahydrofuran (THF), 0 °C; (**3**)† or (**4**),‡ room temperature, 8 h] of the dimethylhydrazone (**6**)[4] of the keto acetal (**5**),[5] followed in each case by removal (2 equiv. $NaIO_4$, pH 7 phosphate buffer, THF, room temperature, 12 h)[4] of the hydrazone moiety, provided the ketones (**7**) (65%) and (**8**) (70%). Conversion [Pr^i_2NMgBr, Me_3SiCl, Et_3N, $(Me_2N)_3PO$, diethyl ether, room temperature, 8 h][6] of compounds (**7**) and (**8**) into the enol silyl ethers (**17**) and (**18**),

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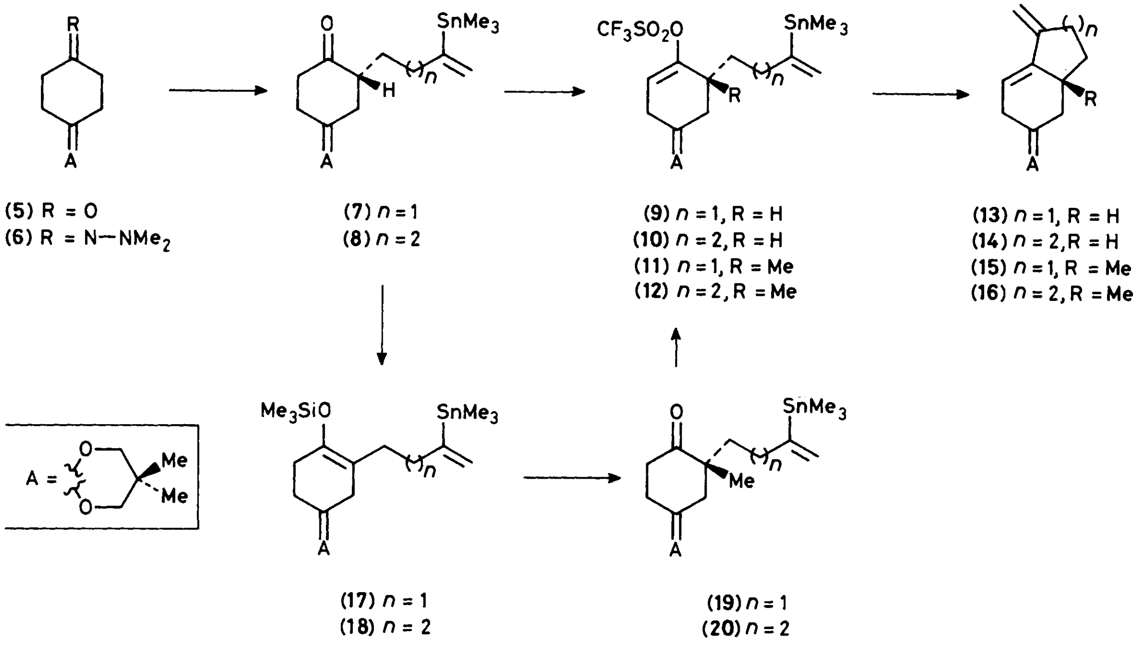
† All compounds exhibited spectra consistent with assigned structures and gave satisfactory molecular mass determinations (high resolution mass spectrometry).

‡ The iodides (**3**) and (**4**) were prepared from 3-trimethylstannylbut-3-en-1-ol (ref. 3) (p-$MeC_6H_4SO_2Cl$, 4-dimethylaminopyridine, CH_2Cl_2; NaI, $HCONMe_2$, 70 °C; 68%) and the chloride (**2**) (ref. 3) (NaI, acetone, reflux; 88%), respectively.



(5) R = O
(6) R = N—NMe$_2$

(7) n = 1
(8) n = 2

(9) n = 1, R = H
(10) n = 2, R = H
(11) n = 1, R = Me
(12) n = 2, R = Me

(13) n = 1, R = H
(14) n = 2, R = H
(15) n = 1, R = Me
(16) n = 2, R = Me

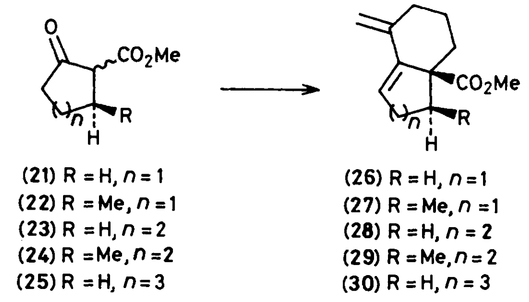
(17) n = 1
(18) n = 2

(19) n = 1
(20) n = 2

followed by treatment with benzyltrimethylammonium fluoride and methyl iodide (THF, room temperature, 8 h),[7] gave the methylated ketones (**19**) (34%) and (**20**) (43%).§

Transformation of the ketones (**7**), (**8**), (**19**), and (**20**) into the corresponding enol trifluoromethanesulphonates (**9**)—(**12**), respectively, was, in each case, accomplished *via* a procedure very similar to that reported by McMurry and Scott.[8] Treatment of compounds (**9**)—(**12**) with a catalytic amount (*ca.* 0.05 equiv.) of $(Ph_3P)_4Pd$ in THF¶ effected efficient ring closure, producing the bicyclic dienes (**13**)—(**16**), respectively, in yields of 83—86%. The cyclization reactions were clean and rapid. The conversions involving formation of the dienes (**13**)—(**15**) were complete after 15 min at room temperature, while refluxing the reaction mixture for the same length of time effected total transformation of (**12**) into (**16**).

Six-membered ring annulations starting from cyclic α-methoxycarbonyl ketones could also be accomplished conveniently. Thus, alkylation (KH, THF) of the keto esters (**21**)—(**25**) with the iodide (**4**),|| conversion of the resultant products into the corresponding enol trifluoromethanesulphonates,[8] and subsequent $(Ph_3P)_4Pd$-catalysed cyclization gave the diene esters (**26**)—(**30**), respectively. The ring closure reactions were generally efficient (yields *ca.* 85%) and clean.



(21) R = H, n = 1
(22) R = Me, n = 1
(23) R = H, n = 2
(24) R = Me, n = 2
(25) R = H, n = 3

(26) R = H, n = 1
(27) R = Me, n = 1
(28) R = H, n = 2
(29) R = Me, n = 2
(30) R = H, n = 3

We acknowledge the Natural Sciences and Engineering Research Council of Canada for financial support, a 1967 Science and Engineering Scholarship (to R. W. F.), and a Postdoctoral Fellowship (to B. A. K.).

Received, 22nd February 1985; Com. 238

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§ Methylation of (**17**) and (**18**) by the Kuwajima procedure (ref. 7) produced, in addition to (**19**) and (**20**), significant amounts of the original ketones (**7**) and (**8**) (41% and 40%, respectively). The yields of the overall conversions of (**7**) and (**8**) into (**19**) and (**20**) have not yet been optimized.

¶ A recent report (W. J. Scott, G. T. Crisp, and J. K. Stille, *J. Am. Chem. Soc.*, 1984, **106**, 4630) described an elegant study involving, *inter alia*, the $(Ph_3P)_4Pd$-catalysed intermolecular coupling of vinyl trifluoromethanesulphonates with vinylstannanes. However, diene formation was observed only when the reactions were carried out in the presence of lithium chloride. In our intramolecular reactions, the dienes were formed cleanly in the absence of LiCl; indeed, addition of LiCl resulted in a very significant decrease in the rate of diene production.

|| Similar attempts to alkylate (**21**) and (**23**) with the iodide (**3**) gave very poor yields of the desired alkylated materials. Apparently, in these cases, elimination predominated over substitution.

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