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# ENOLATE ALKYLATIONS WITH DIETHYLBUTADIENE PHOSPHONATE-I[1-3]

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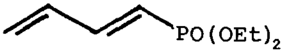
Enolates of various cyclic ketones undergo Michael addition to 1-diethylphosphinyl-1,3-butadiene to yield ketophosphonates.

We would like to report the first successful Michael addition of ketone enolates to diethylbutadiene phosphonate 1.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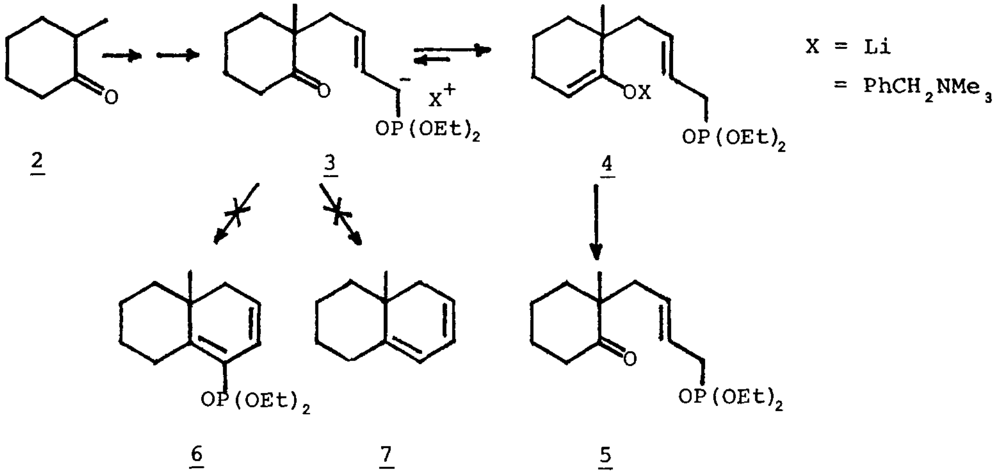
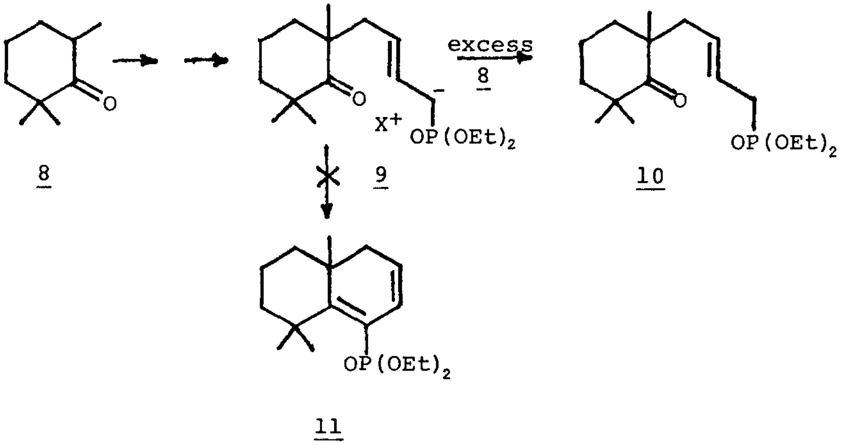
The dienephosphonate 1 is known to undergo (i) nucleophilic addition at position 4,[4] (ii) Diels-Alder reactions with itself as well as standard dienophiles.[5] Recently cycloaddition of 1 with enamines was reported.[6] To date, only very non-basic carbanions such as sodium malonate and sodioacetoacetate have been Michael-added to 1.[4] Our observations indicate that the reactivity of 1, surprisingly, is quite different from that of the corresponding dienephosphonium salt.[7,8]

We generated enolates of various ketones and subjected them to reaction with 1. The results are summarized in the Table. The enolates were generated by: (i) the addition of the ketone to a solution of LDA (Method A), (ii) the treatment of the silyl enol ether[9] of the ketone with benzyltrimethylammonium fluoride (Method B)[10] and (iii) the treatment of the ketone with a suspension of potassium hydride in tetrahydrofuran. When the enolates were produced by Method A, excess ketone (1.1 to 4 equivalents) was used to ensure the formation of the thermodynamic enolate.

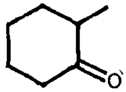
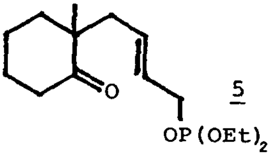
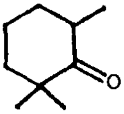
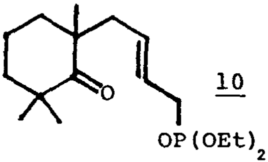
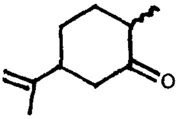
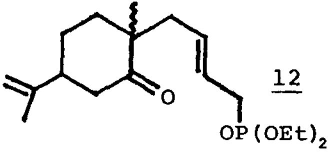
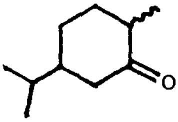
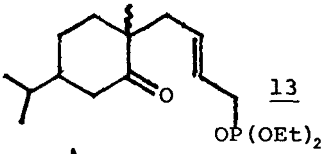
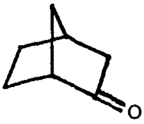
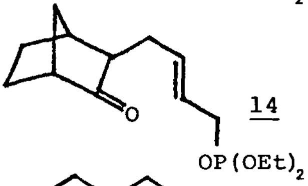
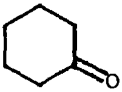
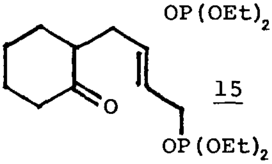
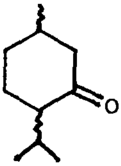
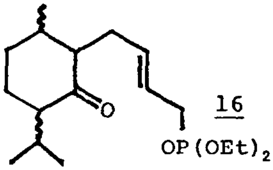
In all cases, the reaction went smoothly to afford ketophosphonates (Michael-adducts). No in-situ cyclization resulting in either Wadsworth-Emmons-type elimination[11] or dehydration[12] was observed. This could be partly due to the Michael-adduct 3 deprotonating itself intra- or intermolecularly giving rise to the more stable 4 which on work up afforded 5. The deprotonation of 3 to give 4 would not occur if the acidic hydrogens (on the α-carbon to the carbonyl) are replaced by alkyl groups. Thus, the use of 2,2,6-trimethylcyclohexanone as the substrate should force the cyclization to occur. But, when the



reaction was carried out in one equivalent of LDA, most of the dienephosphonate 1 underwent polymerization. Only the ketone was recovered. On the other hand, the use of four equivalents of the ketone and one equivalent of LDA in the reaction gave 50% of the ketophosphonate. The intermediate 9 seems to prefer to deprotonate the excess ketone rather than undergo cyclization.



The reaction reported herein appears to be a general one and is of significance in view of the addition of four carbons provided with two functionalities (a double bond and a diethylphosphinyl group). These functional groups can be suitably manipulated or perhaps a cyclization induced to give important compounds. The compounds 12, 13, 14 and 16 thus might serve as useful sesquiterpene precursors.

| Substrate | Procedure | Product[g] | Yield[d] % |
|---|---|---|---|
|  2 | Method A[a]<br>Method B[f] |  5 | 45<br>43 |
|  8 | Method A[b]<br>Method B |  10 | 50<br>60 |
|  | Method A[c]<br>Method C |  12 | 54<br>38 |
|  | Method A[c] |  13 | 58 |
|  | Method A[c] |  14 | 45 |
|  | Method B |  15 | 50 |
|  | Method B[e] |  16 | 36 |

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a. Excess ketone (1.1 or 2 equivalents) was used; b. Four equivalents of ketone were added; c. Two equivalents of the ketone were added; d. Yields were not optimized and correspond to isolated yields; e. The kinetic enolate was trapped with $Me_3SiCl$;[9] f. The thermodynamic enolate was trapped with $Me_3SiCl$;[9] g. NMR, IR and the mass spectral data were consistent with the structures assigned. All the compounds except 14 and 16 were analyzed for C,H content.

These results encouraged us to investigate analogous reactions of enolates of aldehydes bearing only one alpha proton with the dienephosphonate 1, the results of which are summarized in the following communication.

Method A. The ketone was added to a THF solution of LDA at -70°C and after equilibration, the dienephosphonate 1 was introduced into the reaction mixture and the solution was stirred for 1-15 hours.

Method B. The silyl enol ether of the ketone[9] was treated with one equivalent of benzyltrimethylammonium fluoride and one equivalent of the dienephosphonate 1 in THF-$CH_2Cl_2$ mixture and the solution was stirred overnight and refluxed for 48 hours.

Method C. A THF solution of one equivalent of the dienephosphonate 1 was added to a suspension of KH in THF and the solution was refluxed for 4 hours.

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