

# Mechanism of the Reaction of some Organometallic Compounds with $\alpha$ -Enones

Jean Lucchetti and Alain Krief\*

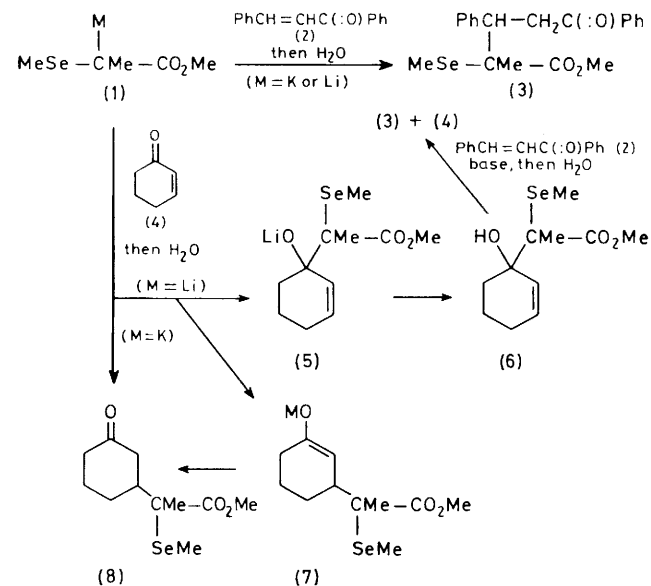
Department of Chemistry, Facultés Universitaires N.D. de la Paix 61, rue de Bruxelles, Namur, Belgium

The stereochemistry of the C-1 and C-3 adducts formed in the reaction of 1-metallo-1-selenopropionates with cyclohexenone is reported as well as the first evidence in favour of the occurrence of a dissociation into two independent species during the base-promoted isomerization of the C-1 to the C-3 adduct.

Addition of organometallic compounds to enones can formally occur at the C-1 and/or the C-3 site of  $\alpha$ -enones.<sup>1</sup> The nature of the two reactants (carbanion and metal; enone) and the conditions (solvent; temperature) are known to affect the results markedly. We now report results obtained during a study of the reaction between methyl 1-metallo-1-methyl-selenopropionates<sup>1</sup> with cyclohexenone and chalcone.

We found that compound (1; M = K)<sup>†</sup> reacts with chalcone (2) or cyclohexenone (4) in tetrahydrofuran (THF) or ether at  $-78$  or  $-110$  °C for 12 min to produce after hydrolysis<sup>‡</sup> exclusively the C-3 adducts (3) and (8) in 75 and 79% yield, respectively (Scheme 1). The lithiated ester (1; M = Li) gives similar results in its reaction with chalcone (2) whereas its reaction with cyclohexenone (4) leads after hydrolysis<sup>‡</sup> to a mixture of both the C-1 and the C-3 adducts (6) and (8) in 75% overall yield and in a ratio of 70:30 (Scheme 1). This ratio is unaffected by reaction time or temperature (12 min or 1 h at  $-78$  or  $-100$  °C). We have isolated the pure adduct (6) and found that it has a high propensity to isomerize to the thermodynamically more stable C-3 adduct (8) on reaction with bases. This occurs spontaneously at  $-78$  or  $-110$  °C with potassium di-isopropylamide in THF or ether and at appreciable rate only at  $-50$  °C with lithium di-isopropylamide in THF.

We then investigated the stereochemical course of the addition reactions. The C-1 and C-3 adducts (6) and (8) can



Scheme 1

<sup>†</sup> Compounds (1; M = Na or K) were prepared by the reaction of (1; M = H) with potassium or sodium di-isopropylamide, prepared by the method of S. Raucher and G. A. Koolpe, *J. Org. Chem.*, 1978, 43, 3795, and references cited therein.

<sup>‡</sup> Reactions were quenched by hydrolysis with saturated aqueous ammonium chloride, at the same temperature as that of the reaction unless otherwise noted.

exist as a pair of diastereoisomers and the knowledge of their relative ratio should be important in understanding the intimate mechanism of the reaction. Thus we found that the cyclohexenol (6) [from (4) and (1; M = Li) in THF at  $-78$  or  $-110$  °C] consisted in fact of a mixture of two stereoisomers (6a) and (6b) in which one predominated [(6a):(6b) = 85:15]. This ratio does not depend upon the reaction time (12 min or 1 h) which suggests that this reaction occurs under kinetic control.

The stereoisomers (6a) and (6b) were separated by preparative layer chromatography on silica with ether-pentane (3:7) as eluant and the structure of the major product (6a) was determined by X-ray crystallography;<sup>2</sup> it has the stereochemistry shown in Figure 1.

We repeated with each pure isomer the base-promoted C-1 to C-3 isomerization ( $\text{LiNPr}_2$ ;  $-50$  °C), and found that they behave differently. The major isomer (6a) exclusively produced (8) as a 1:1 mixture of the stereoisomers (8a) and (8b), whereas the minor isomer (6b) led simultaneously to the formation of both the C-3 adduct (8) and the major C-1 adduct (6a) [as shown by t.l.c. on silica with ether-pentane (3:7) as eluant following hydrolysis]. The major alcohol, in turn, was transformed in that medium ( $-50$  °C; ca. 30 min) into the 1:1 mixture of the stereoisomers (8a) and (8b). We have so far been unable to determine the stereochemistry of the stereoisomers (8a) and (8b). A similar reaction of (6a) and (6b) separately with potassium di-isopropylamide in ether at  $-78$  or  $-110$  °C gave (8) exclusively, but the ratio of (8a) to (8b) was different for the reactions of (6a) and (6b): 40:60 for (6a) and 82:18 for (6b).

These results allow us to discriminate between two possible mechanisms for the C-1 to C-3 isomerization: whether the two reacting units are independent or in a solvent cage.<sup>§</sup> Thus each alcohol (6a) or (6b) was treated with base under the conditions already used ( $\text{LiNPr}_2$  at  $-50$  °C or  $\text{KNPr}_2$  at  $-100$  °C) but the reactions were performed in the presence of 1 equiv. of chalcone. After hydrolysis a large amount of the adduct (3) (70%) was isolated besides a small quantity of cyclohexenone (4) and (1; M = H) (Scheme 1). This indicates that complete dissociation takes place during the base-promoted isomerization of (5) to (7). To the best of our knowledge this result is unprecedented.

It is too early yet to tell if the capture of the seleno-moiety (1) (carbanion or radical) by (3) occurs during the (5)  $\rightarrow$  (7) transfer or during the (5a)  $\rightleftharpoons$  (5b) isomerization. However,

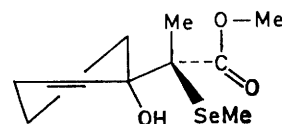


Figure 1. Structure of compound (6a).

<sup>§</sup> In several cases it is impossible to determine whether or not reactions occur in a solvent cage: e.g. the reaction of  $\text{LiNPr}_2$  with the C-1 adduct derived from cyclohex-2-enone and 1-phenyl-1,3-dithian (J. Lucchetti and A. Krief, unpublished work and D. C. Evans, personal communication). We thank Professor Evans for communicating some of his results.

we have ruled out a (7a)  $\rightleftharpoons$  (7b) isomerization, which also can lead to the same result, by a control experiment since we were unable to obtain (3) on reaction of (7; M = K or Li) with chalcone.

The authors are grateful to I.R.S.I.A. (Belgium) for a fellowship to J. L. and to F.N.R.S. (Belgium) for financial support.

*Received, 5th October 1981; Com. 1166*

### References

- 1 A. Krief, *Tetrahedron*, 1980, **36**, 2531 (Report no. 94) and references cited therein.
  - 2 F. Durant and G. Laurent (University of Namur), to be published.
  - 3 Similar observations have been made independently on different enones and organometallic compounds by Professor Maroni and his co-workers.
  - 4 P. C. Ostrowski and V. V. Kane, *Tetrahedron Lett.*, 1977, 3549.
-