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CYCLOPROPANE RING CLOSURE BY REACTION OF ORGANO-MAGNESIUM COMPOUNDS WITH A β-OXO THIOKETONE.

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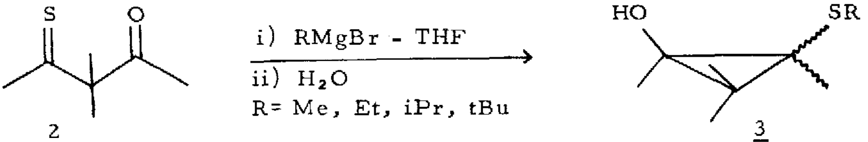
The importance of thiophilic addition of organo-magnesium compounds with thioketones has been demonstrated (1). We recently studied the behaviour of a thioketone bearing an α carbonyl group : exclusive thiophilic addition has been observed, showing the assistance of the adjacent function (2).

This result prompted us to investigate the influence of a carbonyl group situated in the β position of the thiocarbonyl. Only one thioketone bearing a β ketonic group was reported : 2,2,4,4-tetramethyl 3-oxo cyclobutanethione 1 (3). We needed also an alicyclic example such as 3,3-dimethyl 4-oxo pentan-2-thione 2, for which the presence of enol or thio-enol forms may be reasonably ruled out (4). The corresponding diketone has long been known to give, through sulphurization treatment, a dimer of dithioketone (5), presumably of tetrathia adamantane structure (6). However, a controlled moderate treatment of the diketone by hydrogen sulphide in acid medium at a low temperature, allowed us to prepare and isolate the monothio diketone 2 with a suitable yield (7).

At ambient temperature, we ran the reaction of the thioketone 2 in tetrahydrofuran with excessive alkylmagnesium bromides for two hours.

This reaction afforded mainly 2-alkylthio 1,2,3,3,-tetramethyl cyclopropanols 3 (e.g. R= Et, yield= 60 %, GC purity= 90 %) (8, 9). The organic radical of the Grignard reagent is linked to the sulphur atom, in accordance with thiophilic addition.



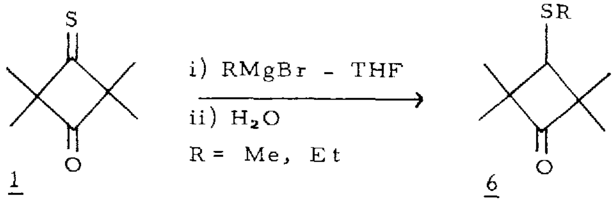
2 3

Two minor components 4 $[CH_3\text{-}CO\text{-}C(CH_3)_2\text{-}CH(SR)\text{-}CH_3]$ and 5 $[CH_3\text{-}CO\text{-}C(CH_3)_2\text{-}C(SR)= CH_2]$ (relative compositions 1-5 % and 5-15 %) have been characterized. Their formation, normal in the light of previous results (1), will be discussed elsewhere.

The new and interesting result here is the closure of a cyclopropane ring (10). Proton n.m.r. spectrum shows that, in each example, a single stereoisomer 3 has been obtained. This stereospecificity seems to be in favour of a concerted mechanism, probably involving an ionic process (11).

[+] This work is part of the thesis J.M. will submit in the near future.

To obtain further information about the transition state of this cyclization, we were interested in the behaviour of the 1,3-cyclobutanonethione 1. Reaction of cyclic compound 1 with alkylmagnesium bromides produced 3-alkylthio cyclobutanones 6 (e.g. R= Me, yield 60 %) (13).



No cyclization reaction was observed. It is to be noted that the carbonyl group remains unattacked in the presence of a large excess of reagent (RMgBr/thione= 5). The superior reactivity of the thiocarbonyl compared to the carbonyl is here evidenced.

The behaviour of the thioketones 1 and 2 is widely different. This leads us to consider that the geometry of the transition state of the closure reaction, derived from alicyclic compound 1 is unfavourable for cyclic compound 2 . The concerted mechanism, giving the cyclopropanol 3,must include a participation of the carbonyl group. In contrast, when such a participation is impossible, only normal thiophilic addition is observed.

These observations make us presume a cis concerted addition. We are now investigating this reaction further to prove the cis stereochemistry of cyclopropanols 3 .

REFERENCES

1 - See references included in ref (2).

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7 - 3,3-dimethyl 4-oxo pentan-2 thione 2 :
Eb_{12}= 69-70° - Yield : 50-60 %. IR (CCl$_4$) : $\nu_{c=o}$: 1695 cm^{-1}.
NMR (CCl$_4$) : 1,42 ppm (s, 3,3-diMe), 2,01 (s, MeCO), 2,62 (s, MeCS).
UV (cyclohexane) : λ_{max} = 521 nm (ϵ = 14), 257 nm (2700), 225 nm (7000).

8 - All compounds have been analysed (C, H, S) : found values agree with calculated ones ± 0,3 %.

9 - e.g. 2-ethylthio 1,2,3,3-tetramethylcyclopropanol :
Eb_{12}= 52-55°. IR (CCl$_4$) : ν_{OH}= 3445 cm^{-1}(large).
NMR (CCl$_4$) : 1,07, 1,11 ppm (s, 3,3-diMe), 1,24 (t, J= 7, Me of SEt), 1,30, 1,35 (s, 1 and 2-Me), 2,58 (q, J= 7, CH_2 of SEt), 2,72 (s, OH disappearing after treatment with D_2O).

10 - D.H. GIBSON and C.H. De PUY, Chem.Rev., 1974, 74, 605.

11 - Another ring closure was observed by reaction of methylmagnesium bromide with a cyclobutane-1,3-dithione that leads to a bicyclobutane (8). Its genesis was however interpreted as involving a radical mechanism in the second step of the reaction.

12 - M. DAGONNEAU, P. METZNER and J. VIALLE, Tetrahedron Letters, 1973, 3675.

13 - e.g. 3-methylthio 2,2,4,4 tetramethylcyclobutanone :
Eb_{20}= 93-95°. IR (CCl$_4$) $\nu_{c=o}$ = 1765 cm^{-1}.
NMR (CCl$_4$) : δ = 1,20, 1,23 ppm (s, 2,2,4,4 tetra Me), 2,10 (s, SMe), 2,98 (s, CH).