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A ONE-STEP SYNTHESIS OF KETONIC COMPOUNDS OF THE PENTALANE, [3,3,3]- AND [4,3,3]-PROPELLANE SERIES

U. Weiss and J. M. Edwards

National Institute of Arthritis and Metabolic
Diseases, Bethesda, Maryland 20014

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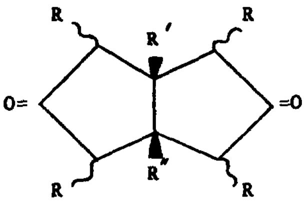
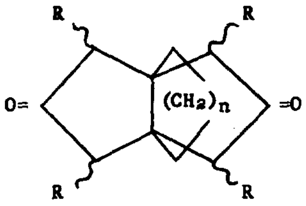
During synthetic work directed towards other objectives, the reaction between dimethyl-3-ketoglutarate (1), and a number of 1,2-dicarbonyl compounds in aqueous solution at room temperature has been investigated. It was observed that this reaction provides a simple and versatile route to certain bi- and tri-cyclic compounds. Several examples are described, but the method appears capable of much further extension. For this reason, and because of current interest in compounds of this type, we wish to present our preliminary results at this time; other commitments will make it impossible to carry out a more detailed study.



2 R=COOMe, R′=R″=H.
3 R=R′=R″=H.
5 R=COOMe, R′=CH_3, R″=H.
6 R=R″=H, R′=Me.
7 R=COOMe, R′=R″=Me.
8 R=H, R′=R″=Me.



9 R=COOMe, n=2.
10 R=COOMe, n=1.
11 R=H, n=2.
12 R=H, n=1.

Glyoxal (1.2 ml., 40% aqueous solution, 10^{-2} mole.) + 1 (3.4 gm., 2 x 10^{-2} mole.) in 200 ml. water at pH 5, stirred for 2 days, deposited a moderate yield (~ 15%)* of the bicyclic compound 2,** which had physical and spectroscopic properties identical with those of authentic 2.[1a,b] However, in contrast with the latter, our sample contained a contaminant of lower mobility on t.l.c. and, on hydrolysis with alkali or, preferably, acid[1a] it gave both the expected[1a,b,2] cis-diketone 3 (m.p. 84-85°, lit.[2] 84-86°) and a less volatile by-product 4 m.p. 148-51° (separated from 3 by fractional vacuum sublimation), $C_{13}H_{16}O_3$ (mass spec.), having an i.r. spectrum almost identical with that of 3. Authentic 2 gave only 3 on hydrolysis, and 4 must thus arise from the contaminant of our preparation, which is very probably the corresponding hexacarbomethoxy compound, formed from 2 moles of glyoxal and 3 moles of 1.

Replacement of glyoxal by pyruvaldehyde gave 5,** (52%, m.p. unsharp 105-113°, from methanol), which was hydrolyzed to 6 (from hexane, m.p. ~ 122° after crystallographic change at 74.5°, indicated by sudden loss of intense polarization colors). 2,3-Butanedione similarly gave the expected intermediate 7** (m.p. 144-6°, sublimed), from which the diketone 8 (m.p. 167-9°, sublimed) was obtained. The cis-stereochemistry of 6 and 8 is inferred from that of 3 and is to be preferred on general grounds to the less stable trans-configuration.[3]

These results suggested that the use of cyclic 1,2-diketones might yield compounds of the propellane[4] series in a single step. In fact, 9 and 10 were obtained from 1,2-cyclohexanedione and 1,2-cyclopentanedione respectively, and were converted without isolation to the propellane diketones 11 and 12 (11: 41%, m.p. 174°; 12: 39%, m.p. 183°; both compounds purified by vacuum sublimation and recrystallization from hexane). The m.p.'s of 6, 8, 11, and 12 are not clearly defined.

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*There is no doubt that conditions giving much improved yields could be worked out.

**This compound is presumably a mixture of stereoisomers differing in the orientation of the COOMe groups.

Compound 11 is identical[5] with a substance of unequivocal structure prepared by Dr. J. Altman through transformation of [4,4,4] propella-8,12-diene-3-one (compound 11 of ref. 4).

All new compounds isolated had correct elemental analysis, molecular weight (mass spec.), and n.m.r. and i.r. spectra in agreement with the proposed structures.

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