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A GENERAL SYNTHESIS OF ESTERS OF ACRYLOYL ACETIC ACID AND THEIR HOMOLOGS.

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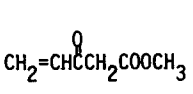
Esters of 3-oxo-4-pentenoic acid such as 1 have found use in synthesis since the work of Nazarov and Zavyalov[1a] who were the first to show their usefulness in the annelation of cyclic β-diketones.



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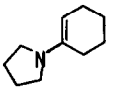
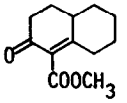
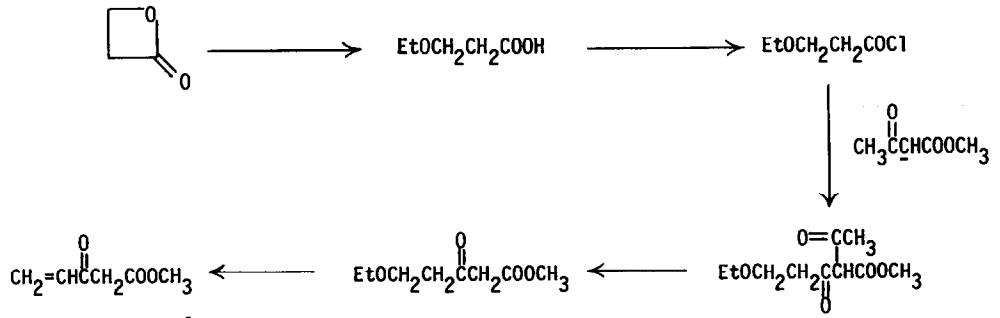


A



B

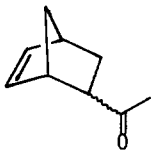
The recently reported[2] extension of the annelation reaction to simple cyclic ketones (via their enamines, cf. A→B) considerably extended the potential usefulness of 1 and its analogs in the regiospecific construction of cyclic β-ketoesters.



The existing method[1], shown above, proceeds only in 7-9% overall yield.

We became convinced, however, that the tediousness and low overall yields of the existing synthesis[1] of 1 was a major deterrent to its general utility. We now report a general and efficient method for the synthesis of 1 and its homologs. Our earlier work on the synthesis of certain cyclopentenones[3] suggested that the approach used in that case - the cracking of formal cyclopentadiene adducts - should be especially suitable for the synthesis of 1. This proved to be the case.

The adduct 2 obtained in almost quantitative yield from cyclopentadiene and methyl vinyl ketone[4] was converted to the β-ketoester 3 by refluxing (16 hr under nitrogen) a mixture of 0.2 mol of 2, 0.6 mol of dimethyl carbonate and 0.42 mol of sodium hydride in 500 ml of glyme. Acidification and work up gave 80-85% yield of 3, bp 87-88° (0.8 mm).



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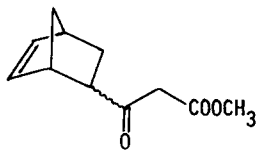

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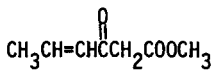
The freshly distilled β-ketoester 3 (0.2 mol) was added over 2.5 hr at the top of a vertical quartz tube (1 ft X 1") packed with quartz chips kept at 600°. The crude product (essentially pure) was collected under reduced pressure (1-2 mm) in a receiver cooled to -30° to -20° and was immediately distilled through a short column[5] to give in 80% yield 1, bp 78-81° (18 mm), identical in its nmr and ir spectra with a sample prepared according to the literature.[1]

The versatility of this new procedure is illustrated by the synthesis of homologs of 1 such as 4 and 5. The only difference is that in the synthesis of the initial adducts 6 (from 3-penten-2-one) and 7 (from 3-methyl-3-buten-2-one) the Diels-Alder addition (0.1 mol each of enone and cyclopentadiene in 20 ml of ether) was carried out in the presence of 100-250 mg of anhydrous aluminum chloride initially at 0°, then at room temperature (spontaneous reflux) overnight. The adducts 6, bp 97-100° (15-20 mm) and 7, bp 90-92°



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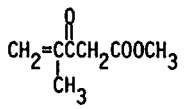

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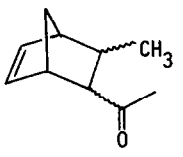

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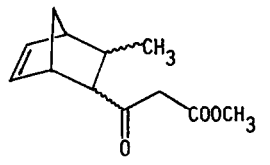

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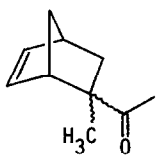

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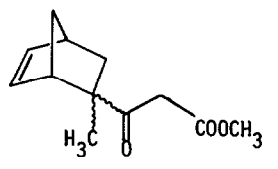

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(12 mm) were obtained in 85% yield and were converted in 85-90% yield exactly as before to 8, bp 105-107° (1 mm) and 9, bp 96-100° (0.6 mm). Cracking (vide supra) then gave in 80% yield the desired unsaturated β-ketoesters 4, bp 95-98° (14 mm) and 5, bp 88-92° (12 mm).[7] The infrared spectrum of 4 (1748, 1678, 1639 and 1608 cm^{-1}) showed the substance to be highly enolic while the isomeric 5 is, as might be expected, largely ketonic (ir 1751, 1712 and 1603 cm^{-1}.)

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References

1. (a) I. N. Nazarov and S. I. Zavyalov, Zh. Obshch. Khim., 23, 1703 (1953).
(b) E. Wenkert, A. Afonso, J. B-son Bredenberg, C. Kaneko and A. Tahara, J. Amer. Chem. Soc., 86, 2038 (1964).

2. Gilbert Stork and R. Nath Guthikonda, in press.

3. G. Stork, G. L. Nelson, F. Rouessac and O. Gringore, J. Amer. Chem. Soc., 93, 3091 (1971).

4. J. G. Dinwiddie Jr. and S. P. McManus, J. Org. Chem., 30, 766 (1965).

5. It is essential to immerse the flask in a preheated oil bath (130-140°) to prevent polymerization.

6. All new compounds reported had ir, nmr and mass spectra in agreement with the expected structures.

7. The unsaturated β-ketoesters 1, 4 and 5 can be stored indefinitely at -20°.