

A FACILE PROCEDURE FOR THE HYDROLYSIS OF  
VINYL HALIDES TO KETONES

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The difficulty that may be encountered in the hydrolysis of vinyl halides to give carbonyl compounds (1→2) frequently vitiates the use of the vinyl halide moiety as a

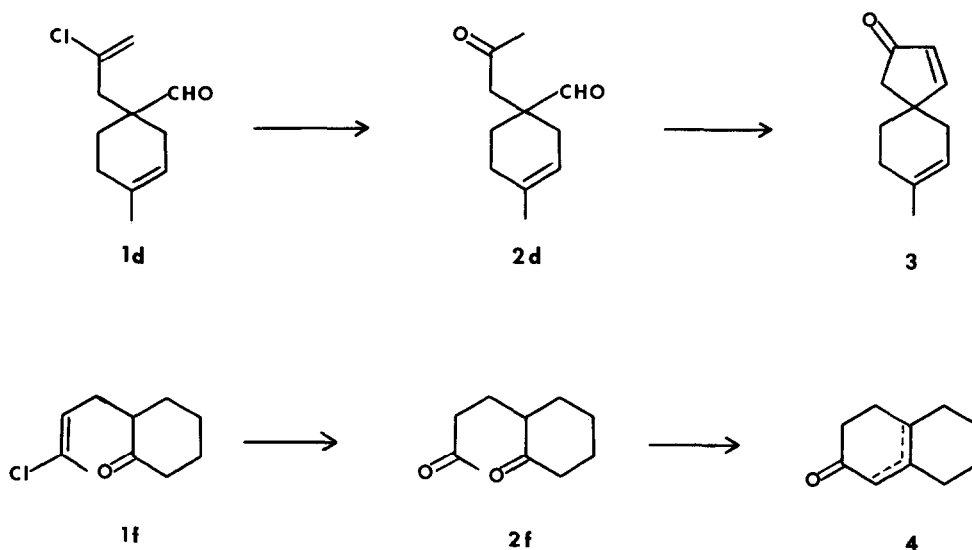


latent carbonyl function in organic synthesis. While a number of procedures may be employed to achieve this important transformation, most require strong acid.<sup>1</sup> Under these drastic conditions a variety of undesired side reactions may ensue, especially in poly-functional molecules. Consequently, several methods have been developed in which transition metals, including Cu(I),<sup>2</sup> Ti(IV),<sup>3</sup> Hg(II),<sup>4,5</sup> and Pd(II),<sup>5</sup> were used in order to allow the hydrolysis of the vinyl halide to proceed under somewhat milder conditions. During the course of a recent synthetic investigation, we required a mild procedure for the conversion of  $\alpha$ -chloroallyl- and  $\alpha$ -chlorocrotylaldehydes and ketones into 1,4- and 1,5-dicarbonyl compounds which were to be used in subsequent annelation operations. Unfortunately, most of the above procedures proved unsatisfactory.<sup>6</sup> Considering the ready availability of the starting vinylhalo carbonyl compounds, this limitation in methodology for the hydrolysis of the vinyl halides was particularly frustrating.

We now wish to report that vinyl chlorides may be readily converted into ketones at room temperature using mercuric acetate in either glacial acetic acid containing boron

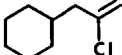
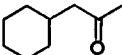
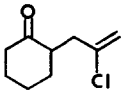
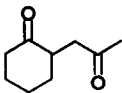
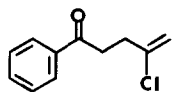
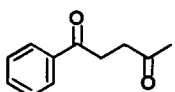
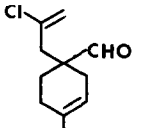
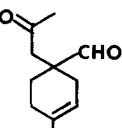
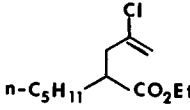
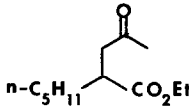
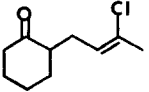
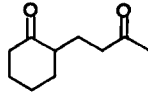
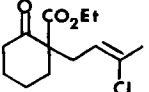
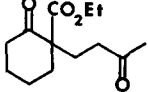
trifluoride etherate (Method A) or in trifluoroacetic acid (Method B). As may be seen upon examination of the entries in Table 1, this convenient procedure affords moderate to excellent yields of ketones from a variety of functionally diverse vinyl chlorides.<sup>7</sup>

There are some important advantages which attend the use of this new method. For example, treatment of 2-(2-chloro-2-propenyl)cyclohexanone (entry b) with mercuric acetate in trifluoroacetic acid afforded 2-(2-oxopropyl)cyclohexanone as the major product whereas attempted hydrolysis with concentrated sulfuric acid produced 2-methyl-4,5,6,7-tetrahydrobenzo[b]furan as the sole isolated product.<sup>8</sup> This mild procedure is especially well suited for the synthesis of cyclopentenones and cyclohexenones by annelation operations as illustrated by the facile conversion of **1d** to **3** in 63% overall yield and of **1f** to **4** in 54% overall yield. Since the successful application of the Wichterle annelation reaction is frequently plagued by side reactions during the hydrolysis step that generates the 3-oxobutyl side chain,<sup>9</sup> this latter example is of special interest.



Hydrolysis of Vinyl Halides, Method A: To a stirred solution of mercuric acetate (1.21 g, 3.8 mmol) in glacial acetic acid (25 ml) was added the vinyl chloride **1** (2.7 mmol). After stirring at room temperature for 5 min, boron trifluoride etherate (0.54 g, 3.8 mmol) was added dropwise, and the resulting mixture was stirred at room temperature for 2-12 hr. The mixture was filtered, and the excess acetic acid was removed *in vacuo*. The residue was cautiously treated with saturated  $\text{NaHCO}_3$  (10 ml) and saturated brine (15 ml) and then extracted with ether (3 x 30 ml). The combined organic layers were dried ( $\text{MgSO}_4$ ) and the excess solvent removed under reduced pressure, and the crude ketones **2** were purified by vacuum distillation.<sup>10</sup>

Table 1. Conversion of Vinyl Chlorides to Ketones (1→2).

| Entry | Starting Vinyl Chloride 1                                                           | Product Ketone 2                                                                    | Method <sup>a</sup> (time,hr) | % Yield <sup>b</sup>               |
|-------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------|------------------------------------|
| a     |    |    | B (1.5)                       | 41                                 |
| b     |    |    | A (2)<br>B (2)                | 52 <sup>c</sup><br>48 <sup>d</sup> |
| c     |    |    | A (12)<br>B (1)               | 52 <sup>e</sup><br>53              |
| d     |    |    | A (10)                        | 71                                 |
| e     |   |   | A (2)<br>B (2)                | 65<br>90                           |
| f     |  |  | A (10)                        | 60                                 |
| g     |  |  | B (2)                         | 55                                 |

<sup>a</sup>Method A,  $\text{Hg}(\text{CH}_3\text{CO}_2)_2/\text{CH}_3\text{CO}_2\text{H}/\text{BF}_3$  etherate/RT; Method B,  $\text{Hg}(\text{CH}_3\text{CO}_2)_2/\text{CF}_3\text{CO}_2\text{H}/\text{RT}$ .

<sup>b</sup>Yields are of distilled product but have not been optimized. <sup>c</sup>A 1:2.5 mixture of 2b and 2-methyl-4,5,6,7-tetrahydrobenzo[b]furan. <sup>d</sup>A 6:1 mixture of 2b and 2-methyl-4,5,6,7-tetrahydrobenzo[b]furan. <sup>e</sup>Contaminated with about 5% of 2-methyl-5-phenylfuran.

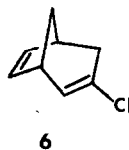
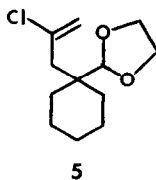
Method B: To a stirred solution of mercuric acetate (1.21 g, 3.8 mmol) in trifluoroacetic acid (20 ml) was added the vinyl chloride 1 (2.7 mmol) and the resulting mixture stirred at room temperature for 1-2 hr. Work-up as above afforded the product ketones 2.

The successful application of this new procedure to the total synthesis of sesquiterpene natural products will be reported independently.<sup>11</sup>

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#### References and Notes

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3. T. Mukaiyama, T. Imamoto, and S. Kobayashi, Chem. Lett., 261 (1973).
4. N. Arzoumanian and J. Metzger, J. Organomet. Chem., 57, C1 (1973).
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6. After the completion of this work, we discovered that a similar procedure using mercuric acetate in formic acid had been very recently reported (reference 5). The use of glacial acetic acid/boron trifluoride etherate or trifluoroacetic acid often appears to give comparable or better results.
7. We have encountered two examples of vinyl chlorides (*i.e.*, 5 and 6) which failed to react during short reaction times and afforded mixtures of products upon prolonged reaction times.



8. E. J. Nienhouse, R. M. Irwin, G. R. Finni, J. Am. Chem. Soc., 89, 4557 (1967).
9. For a brief review of the Wichterle reaction and its limitations see: (a) M. E. Jung, Tetrahedron, 32, 3 (1976); (b) R. E. Gawley, Synthesis, 777 (1976).
10. All compounds were adequately characterized by spectral methods (IR, NMR, and MS) and all new compounds gave satisfactory high resolution mass spectral and/or combustion analytical data.
11. S. F. Martin and T. S. Chou, J. Org. Chem., in press.