

## Favorskii Rearrangement of some $\alpha$ -Bromo-ketones

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THE base-induced rearrangement of  $\alpha$ -halogenoketones to give carboxylic acid derivatives (Favorskii rearrangements<sup>1</sup>) occurs by at least two mechanisms. The stereochemistry<sup>2,3</sup> and structure<sup>4</sup> of many Favorskii products can be explained in terms of a cyclopropanone intermediate. However, a "benzylic-like" rearrangement appears to operate when the substrate ketone bears no  $\alpha'$ -hydrogen,<sup>5</sup> when the  $\alpha'$ -hydrogen is relatively non-acidic,<sup>6</sup> or when steric or strain factors inhibit cyclopropanone formation.<sup>7</sup> In addition, the formation of a dipolar intermediate which may precede (or follow) cyclopropanone formation is supported by theoretical considerations,<sup>8</sup> loss of stereospecificity upon rearrangement in polar solvents,<sup>8</sup> the formation of  $\alpha$ -substitution products<sup>9</sup> as a side reaction, and the trapping of a possible Favorskii intermediate.<sup>10</sup>

"dehydrohalogenate" to form a common intermediate leading to the same product.<sup>1,11</sup>

We report here (Table) our results with the isomeric pairs of  $\alpha$ -bromobutan-2-ones and  $\alpha$ -bromo-3-methylbutan-2-ones which provide strong evidence against (a) a "benzylic-like" rearrangement, (b) a bromine atom exchange from the  $\alpha$ - and  $\alpha'$ -position, and (c) the occurrence of a dipolar ion prior to rearrangement. Comparison of these results with the cleavage of cyclopropanones (or the corresponding hemiacetals) provides strong evidence (a) for the intervention of cyclopropanones [*e.g.* (I)] in the Favorskii rearrangement of the acyclic  $\alpha$ -halogenoketones studied and (b) for the occurrence of side products from base attack on the  $\alpha$ -halogenoketone carbonyl group, not from attack on a dipolar species such as (III).

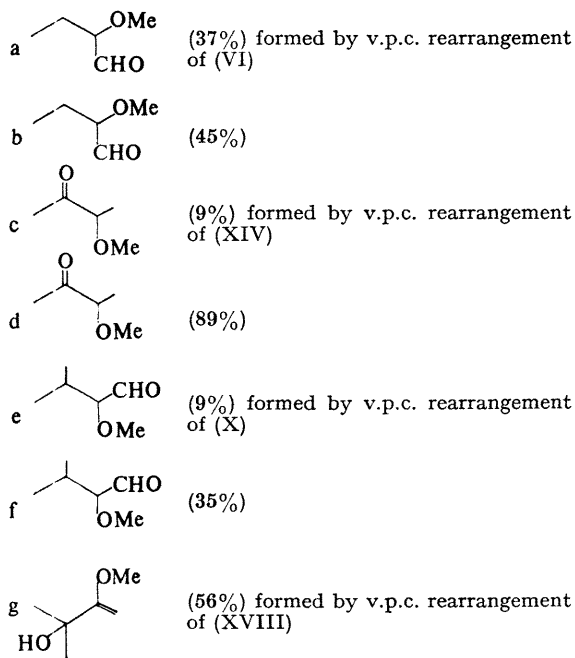
### Reactions with sodium methoxide

	Solvent	Me <sub>2</sub> CH·CO <sub>2</sub> Me %	MeCO·CH(OH)Me %	EtCO·CH <sub>2</sub> OR %
(I and IA)	CH <sub>2</sub> Cl <sub>2</sub>	100		
	MeOH	100		
(IV)	CH <sub>2</sub> Cl <sub>2</sub> <sup>a</sup>	16		24
	Et <sub>2</sub> O	ca. 42		
	MeOH <sup>b</sup>	9		13
(XII)	CH <sub>2</sub> Cl <sub>2</sub> <sup>c</sup>	8	29	
	Et <sub>2</sub> O	36	25	
	MeOH <sup>d</sup>		9	
		Me <sub>2</sub> C·CO <sub>2</sub> Me %	MeCO·CMe <sub>2</sub> ·OR %	Me <sub>2</sub> CH·CO·CH <sub>2</sub> OR %
(II) and (IIA)	CH <sub>2</sub> Cl <sub>2</sub>	100		
	MeOH	100		
(VIII)	CH <sub>2</sub> Cl <sub>2</sub> <sup>e</sup>	2		51
	Et <sub>2</sub> O	2		
	MeOH <sub>4</sub>	9		54
(XVI)	CH <sub>2</sub> Cl <sub>2</sub>	41	28	
	Et <sub>2</sub> O	100		
	MeOH	6	7	

The intermediacy of a dipolar ion was first suggested to explain the fact that isomeric acyclic  $\alpha$ -halogenoketones (*e.g.* PhCl·CH·CO·CH<sup>3</sup> and PhCH<sub>2</sub>·CO·CH<sub>2</sub>Cl) appear to

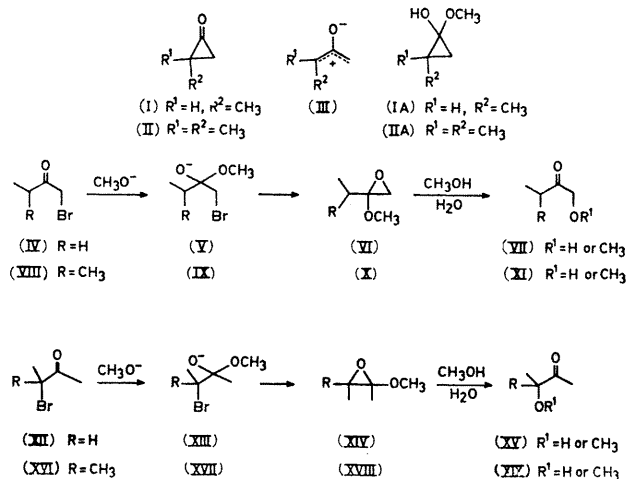
The data reported here require at least two, or possibly more, reaction paths to explain the formation of the major products. Possibilities are: (a) cyclopropanone formation

to account for the formation of rearranged ester and (b) attack on the  $\alpha$ -halogenoketone carbonyl to form epoxyethers which subsequently decompose directly, or upon work up to, yield  $\alpha$ -methoxy-ketones and/or  $\alpha$ -hydroxy-ketones



However, two additional pathways to the  $\alpha$ -methoxy-ketones are available through (c) either  $S_N2$  displacement of halide by base or (d) formation of an allene oxide.

Displacement by base on an epoxy-ether would simply explain the formation of  $\alpha$ -methoxy-ketones. Since the methoxy-epoxides, (VI) and (X) have been detected as the major product before aqueous work up and (VII) and (XI) are not formed until after work-up, route (b) is confirmed as the major route for formation of the  $\alpha$ -substitution products. It should be noted that rearrangement of these epoxides often accompanies their work-up.



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- W. D. McPhee and E. Klingsberg, *J. Amer. Chem. Soc.*, 1944, **66**, 1132; J. G. Aston and J. D. Newkirk, *J. Amer. Chem. Soc.*, 1957, **73**, 3900; it is interesting to note that in the case reported here (2-methyl-3-propylcyclopropanone is presumably produced) only one ester is reported as a result of rearrangement. It is difficult to see why there are not two esters formed.