

## Carbon *versus* Oxygen Alkylation in Reactions of Phenoxide Ions with Cyclopropylmethyl Bromide

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**Summary** Suspensions of phenoxide salts in toluene react with cyclopropylmethyl bromide to give appreciable amounts of alkylation at the *ortho*- and *para*-positions, as well as at the oxygen atom, although cyclopropylmethyl bromide reacts no faster than do simple alkyl bromides, and show no scrambling of the methylene carbons.

phenoxide anions, as well as at the oxygen atoms, when the sodium salts of the phenoxides are suspended in aromatic hydrocarbons.<sup>1-3</sup> Alkyl halides, under the same conditions, react almost entirely at oxygen,<sup>4</sup> except when attack at the oxygen atom is severely inhibited by bulky *ortho*-substituents.<sup>5</sup> Claisen and his group suggested that *C*-alkylation was characteristic of reactive alkylating agents.<sup>1a,6</sup> Curtin and Fraser later suggested<sup>4</sup> that *C*-alkylation was most likely to occur with those halides which undergo

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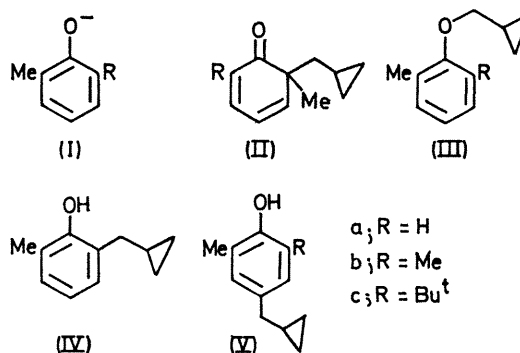
ALLYL and benzyl halides react at the *ortho*-carbons of

substitution at the *lim.* (carbonium ion) end of the mechanistic spectrum, although allyl and benzyl halides do not especially tend to react by *lim.* mechanisms.<sup>6</sup>

We have now investigated the alkylation of sodium phenoxides by cyclopropylmethyl bromide in toluene under reflux. These reactions were uniformly slow. While allyl and benzyl bromides give good yields of alkylation products after several days at room temperature,<sup>1-3</sup> little reaction could be detected with cyclopropylmethyl bromide after 2.5 weeks at room temperature. However, reasonable yields of alkylation products could be obtained after several days in toluene under reflux. The reaction rates of sodium *o*-cresoxide with cyclopropylmethyl and methyl bromides were roughly comparable, although, as with most heterogeneous reactions, rates of individual runs often varied appreciably.

Despite its lack of unusual reactivity, alkylation by cyclopropylmethyl bromide occurred largely on carbon rather than on oxygen. Our observations are summarized in the Table.

carbonium ions. . ."<sup>2</sup> In view of the ease with which the methylene groups of cyclopropylmethyl carbonium ions



become interconverted,<sup>8</sup> we decided to find out whether similar interconversion occurs in the course of the reactions

Anion	Relative yields			
(Ia)	0.7 (IIa)	1.0 (IIIa)	13.0 (IV)	0 (Va)
(Ib)	2.5 (IIb)	1.0 (IIIb)	0 (IV)	1.2 (Vb)
(Ic)	5.0 ± 0.3 <sup>a</sup> (IIc)	1.0 (IIIc)	0 (IV)	3.0 ± 0.1 <sup>a</sup> (Vc)

<sup>a</sup> Average of three runs.

The *ortho*-carbon:oxygen alkylation ratios obtained are similar to those found in reactions with allyl and benzyl halides.<sup>1-3</sup> However, the occurrence of significant amounts of *para*-alkylation from the reactions of the anions of 2,6-dimethylphenol and 6-methyl-2-*t*-butylphenol is noteworthy. In contrast, no alkylation at the *para*-position could be observed in the reaction of sodium 2,6-dimethylphenoxide with allyl or benzyl bromides.<sup>2</sup> A re-examination of these reactions showed that less than 0.5% of the *p*-alkylated phenols could be detected by g.l.c. The possibility that the apparent *para*-alkylation might result from rearrangements of cyclohexadienones was rejected, since the cyclohexadienones, as well as the aryl cyclopropylmethyl ethers, were quite stable in toluene under reflux, while reaction of the dienones with acid resulted largely in cleavage of the cyclopropylmethyl groups from the rings, rather than rearrangements. Therefore, the 4-cyclopropylmethylphenols must have been formed during the alkylation processes.

*para*-Alkylation has previously been observed only with such active alkylating agents as trityl chloride,<sup>7†</sup> and has been considered to be "diagnostic of the intermediacy of

reported here. Sodium 6-methyl-2-*t*-butylphenoxide was treated with cyclopropyl[<sup>2</sup>H<sub>2</sub>]methyl bromide, containing 1.8 atoms of deuterium at the bromomethyl carbon. The dienone, ether, and *para*-alkylated phenol obtained from the reactions each contained 1.8 ± 0.1 atoms of deuterium at the methylene carbon bearing the cyclopropyl group (n.m.r. analysis). Thus, within experimental error, no scrambling of the ring and exocyclic methylene carbons occurs in these reactions.

Our results support the generalization that *C*-alkylation, and particularly alkylation at the *para*-position, is favoured by the use of alkylating agents which tend to form unusually stable carbonium ions. It is interesting that this effect is observed in a reaction which does not resemble a carbonium ion process in any other way.

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† An exception is the alkylation of potassium 2,6-di-*t*-butylphenoxide, which gives significant amounts of *para*-alkylation.<sup>5</sup>

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