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REDUCTION OF AROMATIC HALIDES WITH LITHIUM ALUMINUM HYDRIDE
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Only a few reductions of aromatic halides with lithium aluminum hydride have been reported. For example, three hour reflux of p-bromotoluene in tetrahydrofuran with a mixture of lithium aluminum hydride and lithium hydride (1) yields 14% toluene; o-chloroiodobenzene gives 40% chlorobenzene (2) after one-half hour reflux in tetrahydrofuran; a 51% yield of 2,3,5,6-tetrafluorotrifluoromethylbenzene is obtained from pentafluorotrifluoromethylbenzene (3) after eighty-five hour reflux in ether; and for certain halonitrobenzenes iodo and -- when activated -bromo reduction accompanies the reduction of the nitro group (4).

Prompted by reaction (a) we investigated several aromatic halides in



order to elucidate the structural features and reaction conditions that might facilitate such reductions. Table I summarizes pertinent data.

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## TABLE I

## Reducation of Aromatic Halides with Lithium Aluminum Hydride

	Compound	Time (hr.)	Solventa	% Halide Reduced	<b>%</b> Acid Recovered
1.	o-Bromctoluene	24	Et <sub>2</sub> 0	4	
2.	o-Bromctoluene	24	THF	13	
3.	o-Chlorobenzoic acid	24	THF	3 <sup>c</sup>	
4.	m-Chlorobenzoic acid	24	THF	o <sup>c</sup>	
5.	o-Bromobenzoic acid	24	Et <sub>2</sub> 0	19 <sup>0</sup>	
6.	o-Bromobenzoic acid	24	THF	100	
7.	m-Bromobenzoic acid	24	Et <sub>2</sub> 0	0 <sup>e</sup>	
8.	m-Bromobenzoic acid	24	THF	63 <sup>°</sup>	
9.	p-Bromobenzoic acid	24	THF	68 <sup>c</sup>	
10.	o-Iodobenzoic acid	24	Et <sub>2</sub> 0	100	
11.	o-Iodobenzoic acid	24	THF	100	
12.	m-Iodobenzoic acid	24	Et <sub>2</sub> 0	73 <sup>°</sup>	
13.	m-Iodobenzoic acid	24	THF	100	
14.	p-Iodobenzoic acid	24	Et <sub>2</sub> 0	70 <sup>°</sup>	
15.	p-Iodobenzoic acid	24	THF	100	
16.	1-Bromonaphthalene	24	Et <sub>2</sub> 0	6	
17.	1-Bromonaphthalene	24	THF	49	
18.	2-Bromonaphthalene	24	THF	21	
19.	8-Bromo-1-methylnaphthalen	e 24	Et <sub>2</sub> 0	11	
20.	8-Bromo-1-methylnaphthalen	e 24	THF	46	
21.	8-Bromo-1-naphthylcarbinol	24	Et <sub>2</sub> 0	19	
22.	8-Bromo-1-naphthylcarbinol	1	THF	36	
23.	8-Bromo-1-naphthylcarbinol	8	THF	97	
24.	8-Bromp-1-naphthoic acid	3	Et <sub>2</sub> 0	27 <sup>c</sup>	59

	Compound	Time (hr.)	Solvent <sup>a</sup>	% Halide Reduced	% Acid Recovered
25.	8-Bromo-1-naphthoic acid	24	<b>Et</b> 2 <sup>0</sup>	64 <sup>°</sup>	36
26.	8-Bromo-1-naphthoic acid	<u>7</u> 6	Et <sub>2</sub> 0	99 <sup>°</sup>	
27.	8-Bromo-1-naphthoic acid	24	THF <sup>d</sup>	69 <sup>°</sup>	16
28.	8-Bromo-1-naphthoic acid	24	THF	100	
29.	Methyl 8-Bromo-1-naphthoat	ce 24	Et <sub>2</sub> 0	60 <sup>°</sup>	
30.	8-Bromo-1-bromomethyl- naphthalene	1	Et <sub>2</sub> 0	5 <sup>e</sup>	

## TABLE I (CONT.)

<sup>a</sup>Reductions were carried out at reflux temperatures. <sup>b</sup>Percent values accurate to  $\pm 5\%$ , were determined by n.m.r. and in several cases by v.p.c. <sup>C</sup>The remaining percent is halocarbinol. In entries 2<sup>4</sup>, 25 and 27 these percentages are 73, 36 and 31. <sup>d</sup>Carried out at room temperature. <sup>e</sup>The remaining 95% is 8-Bromo-1methylnaphthalene.

Contrary to current views, many of these reductions occur with such ease that they become competitive with the reduction of carboxyl groups (entries 24, 25 and 27.) As evidenced by entries 25, 27, 28, the more extensive reduction in tetrahydrofuran than in ether arises mainly from differences in reaction temperature.

The overall reaction mechanism is nucleophilic substitution without aryne intermediacy, as evidenced by (b). In addition to halogen reactivity (iodo)



bromo > chloro) and to activation of halide by electron withdrawing groups, two structural features affect the reaction rate:

(i) Increase in ground state steric interactions between halogen and neighboring groups. Such interactions increase reduction (compare entries 17 and 18) presumably because of steric relief in converting the trigonal carbon to tetrahedral.

(ii) Presence of groups, capable of forming alkoxides with lithium aluminum hydride, <u>ortho</u> or <u>peri</u> to the halogen. Such features increase reduction, undoubtedly as a result of cyclic transition states (I).



Ample support is provided by chlorohydrins (II) (5),  $\alpha$ -hydroxyacetylenes(III), and the carbon-carbon double bond reductions of several  $\alpha$ ,  $\beta$ -unsaturated carbonyl compounds.

Although any synthetic advantages that the above structural features may offer have yet to be explored in terms of reaction temperature and solvent, it is clear that such reductions can be advantageously used to synthesize deuterated compounds that are unaccessible by simple and rapid synthetic methods.

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