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REACTIONS OF A CYCLIC α, β -UNSATURATED KETONE:
4,4-DIMETHYL-1-KETO-1,4-DIHYDRONAPHTHALENE

by

Harold H. Eby

A THESIS

Presented to the Faculty of
The Graduate College in the University of Nebraska
In Partial Fulfillment of Requirements for the
Degree of Doctor of Philosophy
Department of Chemistry

Under the Supervision of Dr. N. H. Cromwell

Lincoln, Nebraska

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• 474290

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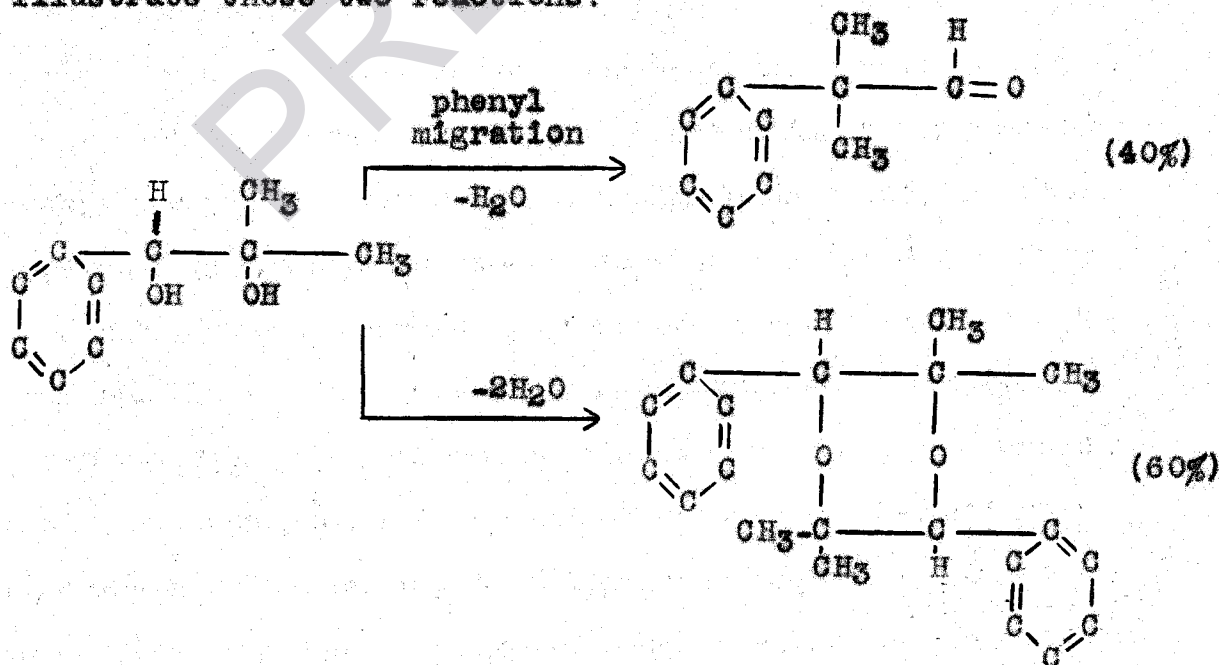
I. INTRODUCTION

A. Historical

1. Synthesis of 4,4-Dimethyl-1-keto-1,4-dihydronaphthalene

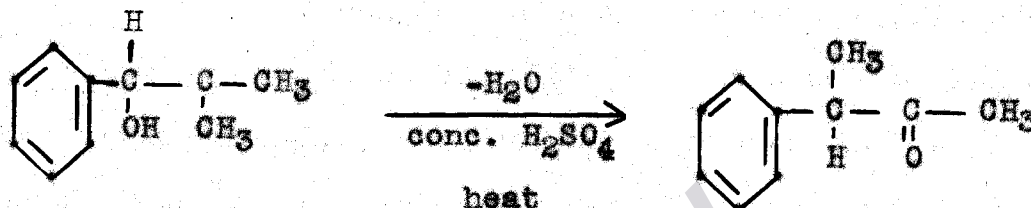
a. α,α -Dimethylphenylacetaldehyde (III)

This aldehyde has been prepared by Tiffeneau and Dorlencourt¹ by the action of dilute sulfuric acid on 1-phenyl-2-methylpropanediol-1,2, a glycol they prepared in low yields by treating methyl mandelate with methyl magnesium iodide. Later, Levy² reported that two products were produced when 1-phenyl-2-methylpropanediol-1,2 was heated with dilute sulfuric acid. Forty per cent of the crude product consisted of the desired α,α -dimethylphenylacetaldehyde distilling from 105-110°C (14 mm.). The remainder sixty per cent was the diethylenic oxide of the glycol. The following equations illustrate these two reactions:



This oxide was converted to the aldehyde by heating it with pumice moistened with sulfuric acid. No conversion was produced by further heating the oxide with sulfuric acid.

Concentrated sulfuric acid caused one methyl group of the glycol to migrate rather than the phenyl, thus giving a ketone rather than the aldehyde:



Heating the glycol with 50% oxalic acid produced almost exclusively the diethylenic oxide while phosphorus pentoxide gave a mixture of the aldehyde and the ketone.

³
Darzens states that compounds of the type:



where "R" is high, give almost theoretical yields of the aldehydes when heated at reflux temperature for about four hours with anhydrous formic acid.

⁴
Wallach prepared α, α -dimethylphenylacetic acid (IV) by condensing benzene with α -bromoisobutyric acid under the influence of aluminum tribromide. Brander ⁵ obtained 37% yield of the ester by substituting for the α -bromoisobutyric acid, its ester and using a large excess of aluminum chloride.

By heating benzyl cyanide with sodamide and methyl iodide, Haller and Bauer⁶ succeeded in replacing the active hydrogens of the benzyl group to obtain α, α -dimethylphenylacetonitrile. Hydrolysis of this cyanide gave the expected α, α -dimethylphenylacetic acid.

Possibly, the acid chloride or ester of this substituted acetic acid could be reduced to α, α -dimethylphenylacetaldehyde by the Rosenmund method of reduction.

b. Condensation reactions of aldehydes

Most aldehydes condense with malonic acid with the evolution of carbon dioxide to yield α, β -unsaturated acids. Thus, both phenylacetaldehyde⁷ and α -methylphenylacetaldehyde (hydratropic aldehyde)⁸ condense with it to give good yields of the expected unsaturated acids. Best results are usually obtained by heating equimolar quantities of the aldehyde, malonic acid, and pyridine on a steam bath until no further carbon dioxide is evolved. One or two drops of piperidine often increases the yield.

Pivaldehyde (trimethylacetaldehyde) condenses readily⁹ malonic ester¹⁰ and acetone.

In view of these aldehyde reactions, it was hoped that α, α -dimethylphenylacetaldehyde would condense with malonic acid to give γ, δ -dimethyl- δ -phenylcrotonic acid (V) or with acetone or malonic ester to give the corresponding condensed products.

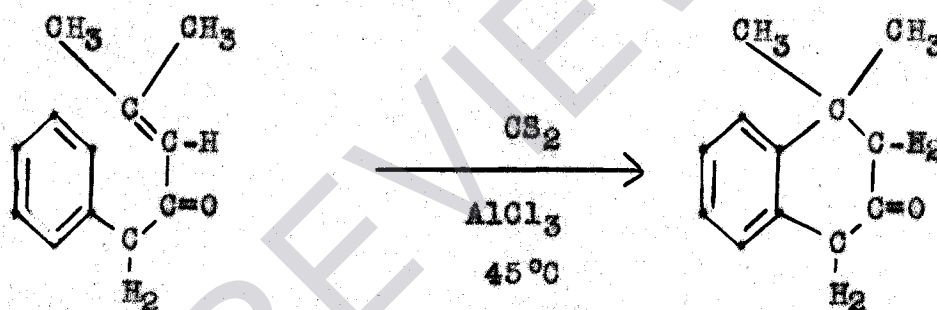
c. Ketones by ring closures

Acid chlorides of β -phenylpropionic or

γ -phenylbutyric acids can be cyclized to yield cyclic ketones. Double bonds may be present in the side chains. Thus, γ -phenylbutyric acid gives α -tetralone¹¹ in 74-91% yields by the action of aluminum chloride on the acid chloride.

Koelsch¹² cyclized triarylacrylic acids to indones by means of thionyl chloride in carbon tetrachloride solutions.

It was shown by Colonge and Chambion¹³ that two methyl groups attached to the carbon joining the ring did not prevent ring closure by steric factors. They cyclized 1-phenyl-4-methylpentene-3-one-2 to 1,1-dimethyltetralone-3 by the action of aluminum chloride:



After considering these ring closure reactions, it was hoped that γ, γ -dimethyl- γ -phenylcrotonic acid (V) could be cyclized to 4,4-dimethyl-1-keto-1,4-dihydronaphthalene (XII) by heating the free acid with thionyl chloride or the acid chloride with aluminum chloride.

d. Another synthesis of 4,4-dimethyl-1-keto-1,4-dihydronaphthalene

While this work was in progress, Arnold,¹⁴ Buckley, and Richter prepared this unsaturated cyclic ketone

starting from ethyl levulinate (VIII). By adding methyl magnesium iodide to an ether-benzene solution of this ester, γ, γ -dimethylbutyrolactone (IX) was formed which was condensed with benzene under the influence of aluminum chloride to give 4,4-dimethyl-1-tetralone (X). Bromine substituted readily into this saturated ketone to give 2-bromo-4,4-dimethyl-1-tetralone (XI) which lost HBr on being heated under reflux with the base, collidine, thus forming the desired 4,4-dimethyl-1-keto-1,4-dihydronaphthalene (XII).

Arnold found that this unsaturated ketone, 4,4-dimethyl-1-keto-1,4-dihydronaphthalene, rearranged in acid solution to give 3,4-dimethyl-1-naphthol (XIV).

2. Review of the Chemistry of α, β -Unsaturated Ketones and their Bromine Derivatives

a. Reactions of Grignard reagents with α, β -unsaturated ketones

Grignard reagents react with α, β -unsaturated ketones to give unsaturated tertiary alcohols (or their dehydrated products--hydrocarbons) by 1,2-addition, saturated ketones by 1,4-addition or both. The manner of addition depends upon the number, kind, and positions of the substituents on the carbonyl compound and upon the group present in the Grignard reagent. ¹⁵ As the activity of the carbonyl group decreases, the amount of 1,4-addition increases. For example, β -phenylbenzalacetophenone gives no 1,4-addition with phenyl magnesium bromide and only 18% with ethyl magnesium bromide while α -phenylbenzalacetophenone gives 100% 1,4-addition