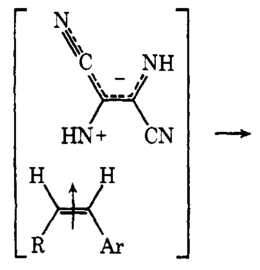

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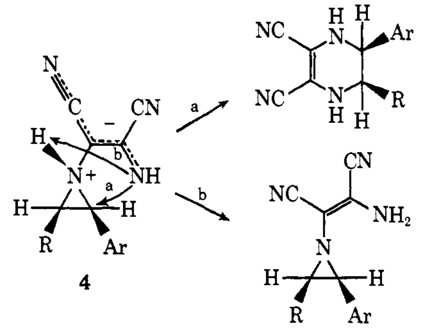
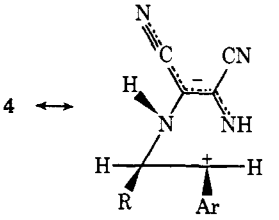


(2)

results in the formation of aziridines. A sigmatropic ${}_{\sigma}2_s + {}_{\pi}4_s$ migration of the carbon bearing an aryl group to the amido nitrogen, on the other hand, can give rise to 2,3-dicyano-1,4,5,6-tetrahydropyrazines with retention of olefin stereochemistry. Consistent with this mechanism is the observation that as the electron-donating power of the aryl group increases, the reaction becomes more facile and the formation of dicyanotetrahydropyrazine becomes more favorable. The latter may be expected because the bond between the ring nitrogen and the carbon-bearing aryl group in **4** becomes weaker as the resonance contribution of **4a** to the zwitterionic aziridinium ion **4** increases (eq 3). This two-step stereospecific formation of 2,3-dicyano-1,4,5,6-tetrahydropyrazine, however, cannot be differentiated from the direct 2 + 4 cycloaddition between DISN and olefins by presently available data. Reactions of DISN with other olefins and a detailed discussion of the mechanism will be reported upon completion of this work.



4a

(3)

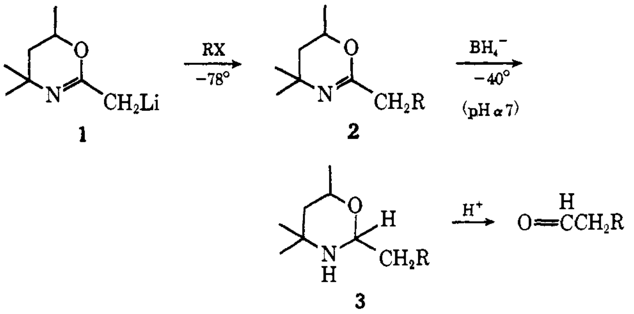
T. Fukunaga
Contribution No. 1818, Central Research Department
Experimental Station, E. I. du Pont de Nemours and Company
Wilmington, Delaware 19898

Received February 8, 1972

Dihydro-1,3-oxazines. XV. A Two-Carbon Homologation of Alkyl Halides to Aldehydes Using a Novel Ketene *N*,*O*-Acetal

Sir:

The alkylation of 2-methyldihydro-1,3-oxazines *via* their lithio salt **1** at −78° has been shown to provide suitable precursors **2** which were converted under pH-controlled borohydride reduction to masked aldehydes **3** and ultimately to aldehydes by acidic cleavage.[1] Although many examples were provided to demonstrate the utility of this sequence,[2] it still suffers from several disadvantages: (a) successive low-temperature steps are required for the formation of **2** and **3**, (b) the use of alkyllithium reagents which are not universally available, and (c) isolation of **2** and **3** which results in loss of material and time.



We describe in this preliminary report a significant and efficient modification of the sequence which originates from the methiodide salt (**4**)[3] of the readily available starting oxazine **5**. The methiodide salts have been used earlier to prepare ketones by addition of organometallic reagents to the C=N link followed by hydrolytic cleavage.[4] In this instance, however, **4** was smoothly transformed into the ketene *N*,*O*-acetal[5] **6** [91%; bp 94–95° (30 mm); ir 1625 cm^{-1}; nmr (benzene) δ 3.08, 3.69 (d, J = 2 Hz) assigned to the vinyl protons] which was highly sensitive to moisture, rapidly forming the amino ester **9**. The ketene *N*,*O*-acetal was also successfully prepared (87%) by the base-catalyzed cleavage of the methiodide salt **8** (mp 136.5–138°) obtained by treating the acetone adduct **7**[6] with methyl iodide (dimethylformamide, 70°). It was felt that **6** would behave as a highly nucleophilic enamine due to its unusual high-field vinyl proton signals. This suggests considerable contribution from canonical form **6a** to its ground-state structure.[7] Due to the unstable nature of **6** and its difficulty in handling, we found that it may be conveniently prepared *in situ*. Thus, by treating the methiodide salt **4** in dimethylformamide with sodium hydride (2 equiv) followed by the addition of an alkyl halide, the elaborated oxazinium salt **10** was rapidly produced. The latter is immediately neutralized by the second equivalent of sodium hydride present to the ketene *N*,*O*-acetal **11** and treated with an ethanolic solution of sodium borohydride forming **12**.

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(1) A. I. Meyers, A. Nabeya, H. W. Adickes, and I. R. Politzer, *J. Amer. Chem. Soc.*, **91**, 763 (1969).

(2) For preparative details, see J. M. Fitzpatrick, G. R. Malone, I. R. Politzer, H. W. Adickes, and A. I. Meyers, *Org. Proc. Prep.*, **1**, 193 (1969).

(3) Prepared by stirring a mixture of 5 and 4.0 equiv of methyl iodide in the dark for 20 hr. Filtration and washing with ether produced a 92% yield of 4: mp 156–158°; ir (KBr) 1610 cm^{-1} ($\text{O}{\cdots}\text{C}^{+}{\cdots}\text{NCH}_3$).

(4) A. I. Meyers and E. M. Smith, *J. Amer. Chem. Soc.*, **92**, 1084 (1970).

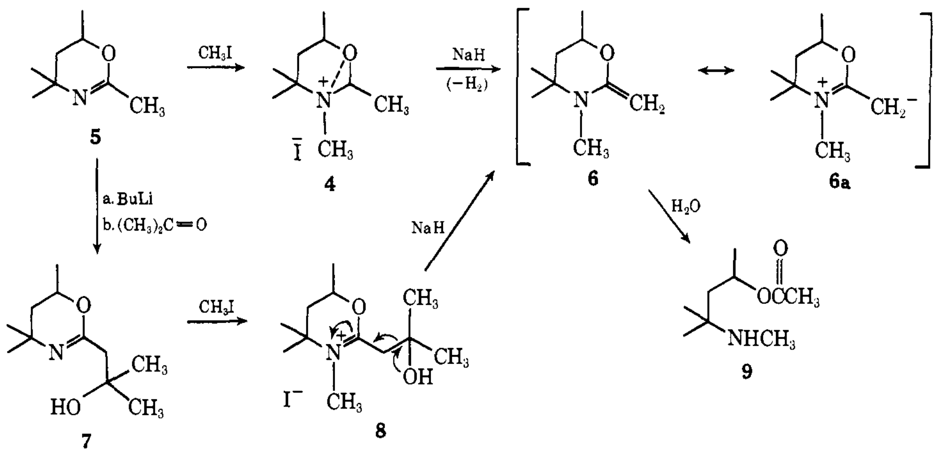
(5) Ketene *N*,*O*-acetals of the type $\text{H}_2\text{C}{=}\text{CORNR}_2$ have been previously prepared by base-catalyzed neutralization of the adduct from *N*,*N*-dimethylacetamide and triethyloxonium fluoroborate [H. Meerwein, W. Florian, N. Schon, and G. Stopp, *Justus Liebigs Ann. Chem.*, **641**, 1 (1961)]. Alkylation of amide acetals to homologated amides has been reported to arise from ketene *N*,*O*-acetals which were presumed to be intermediates [T. Oishi, M. Nagai, and Y. Ban, *Tetrahedron Lett.*, 4, 497 (1968); T. Oishi, S. Murakami, Y. Sakurai, H. Nakakimura, and Y. Ban, Abstracts of the Third International Congress of Heterocyclic Chemistry, B, Sendai, Japan, 1971, p 125].

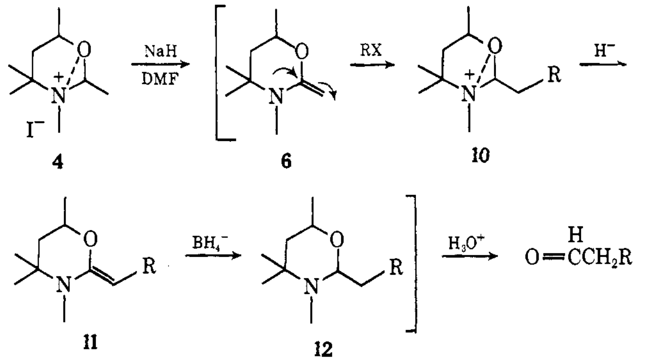
(6) A. I. Meyers, A. Nabeya, H. W. Adickes, J. M. Fitzpatrick, G. R. Malone, and I. R. Politzer, *J. Amer. Chem. Soc.*, **91**, 764 (1969).

Table I. Formation of Aldehydes from *N*-2,4,4,6-Pentamethyl-5,6-dihydro-1,3-oxazinium Iodide (**4**)

RX	Aldehyde	% aldehyde (overall)[a]	2,4-DNP mp, °C (lit.)
$PhCH_2CH_2CH_2I$	$OHCCH_2CH_2CH_2CH_2Ph$	51	97.5–99
$H_2C{=}C(\text{-}Br)CH_2Br$	$OHCCH_2CH_2C(\text{-}Br){=}CH_2$	60	104–105[b,c]
$PhCH_2Br$	$OHCCH_2CH_2Ph$	58	153–155 (153–154)[d]

[a] Crude yields (estimated by nmr and vpc to be 90–95% pure). [b] Semicarbazone derivative. [c] New compound, analytical data were satisfactory. [d] See ref 1.



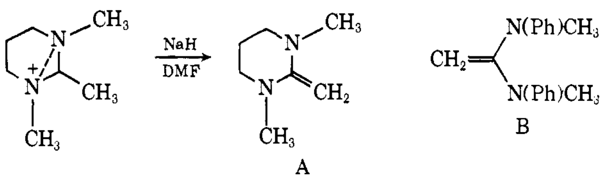


The entire sequence up to this point was performed in a single vessel. Hydrolytic cleavage of **12** led to the aldehydic product (Table I). The method requires the use of 2.0 equiv of sodium hydride since the newly formed oxazinium salt **10** is capable of consuming unreacted **6** by proton transfer. Thus, it must be neutralized as quickly as it forms (**10** → **11**). The use of 1 equiv of sodium hydride results in a considerable amount of starting salt **4** along with dialkylated oxazine derived from further alkylation of **11**. It was both surprising and fortunate that the reaction, which is designed to allow the simultaneous presence of both ketene *N*,*O*-acetals (**6** and **11**), proceeds solely[8] by alkylation of the less-hindered methylene group **6**.

Several advantages to the present method over that reported earlier[1] should be emphasized: (a) the starting material **4** is a stable, storable, crystalline material; (b) the handling of sodium hydride is more practical than butyllithium; (c) the entire sequence requires 4–6 hr (as opposed to 2 days in the original procedure; (d) it avoids the pH-sensitive borohydride reduction; and (e) all steps are performed at, or close to, room temperature which should enhance its synthetic usefulness.[9]

The following typical procedure for the preparation of 5-phenylvaleraldehyde demonstrates the process. The methiodide salt **4** (58 mmol) contained in gouch tubing was added in small portions to a mechanically stirred suspension of sodium hydride (122 mmol) in dry dimethylformamide (150 ml) at room temperature. The reaction mixture was allowed to stir until hydrogen evolution ceased (20–30 min) and then treated dropwise with 3-iodopropylbenzene (65 mmol). After the addition, the reaction flask was placed in an oil bath and the temperature slowly raised until hydrogen evolution was observed (50°)[10] and the reaction mixture was stirred at 50–55° until hydrogen evolution stopped (60–90 min). The mixture was cooled with an ice bath and a mixture of sodium borohydride (58 mmol) in absolute ethanol (30 ml) was added in one lot. Reaction was allowed to proceed with cooling for an additional 45 min followed by quenching over 100 ml of ice–water. The crude tetrahydrooxazine was removed by thorough ether extraction and, after concentration and removal of unreacted components *in vacuo* (0.1 mm), was hydrolyzed by an aqueous oxalic acid (250 mmol/75 ml) solution subjected to steam distillation.[2] The distillate, first saturated with sodium chloride, was efficiently extracted with ether, and the combined extracts were dried,

[7] For vinyl signals in enamines see A. G. Cook, "Enamines: Synthesis, Structure and Reactions," Marcel Dekker, New York, N. Y., 1969. We have also prepared the ketene animal A, by the procedure described for generating **6**, which shows the vinyl signals at δ 3.18 (s).



A report by C. Jutz and H. Amschler [*Chem. Ber.*, **96**, 2100 (1963)] assigns the vinyl signals of B at 4.12 ppm.

[8] The enamine alkylation of **11** proceeds only with difficulty although it may be made more facile when the reaction is heated for prolonged periods and in the absence of the competing enamine **6**.

[9] Although alkyl bromides, iodides, and activated chlorides appear to alkylate **6** smoothly, saturated alkyl chlorides do not react.

[10] Strongly electrophilic halides such as allyl bromide and benzyl bromide react at room temperature; consequently heating should be avoided.

filtered, and concentrated to give 4.76 g (51% overall yield) of 5-phenylvaleraldehyde (90–95% pure by vpc and nmr).[11]

Further studies are currently in progress to evaluate fully the potential of this synthetic method for obtaining a wide variety of aldehydes including those possessing additional functional groups.

Acknowledgment. Financial assistance from the National Science Foundation (GP 28687) and the Petroleum Research Fund administered by the American Chemical Society is gratefully acknowledged.

[11] All final products gave satisfactory mass, ir, nmr, and elemental analyses.

A. I. Meyers,* Nicholas Nazarenko
Department of Chemistry, Wayne State University
Detroit, Michigan 48202

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Entrance onto Potential Energy Surfaces of Photochemical Reactions without Light. The Type B Reaction. Mechanistic Organic Photochemistry. LXVI[1]

Sir:

In 1961 we proposed mechanisms for the types A and B rearrangements in dienone photochemistry.[2] More recently we described the generation without light of zwitterionic intermediates now commonly accepted in the mechanism of the type A reaction.[3]

Presently we report generation without light of the zwitterion proposed[2] for the type B photochemical rearrangement in which 6,6-disubstituted bicyclo[3.1.0]hex-3-en-2-ones afford 2,3- and 3,4-disubstituted phenolic products and their tautomers.[4] The present results are sufficiently convincing that complete confirmation of the intermediacy of these zwitterions—for which considerable circumstantial evidence is available[2,5]—is now a reality.

We report: (1) generation of zwitterion B from the *tert*-butoxide treatment of 6-bromo-5,5-diphenylcyclohex-2-en-1-one (**1**),[6] (2) the observation of the same two phenols—2,3-diphenylphenol (**2**) and 3,4-diphenylphenol (**3**)—formed in the type B rearrangement of 6,6-diphenylbicyclo[3.1.0]hex-3-en-2-one (**4**),[2,7] (3) the identity of the ratios of these products from the dark and photochemical runs, and (4) the observation of identical solvent dependences of the dark and photochemical ratios of the two phenols **2** and **3**.

6-Bromo-5,5-diphenylcyclohex-2-en-1-one (**1**), mp 166°, was synthesized by pyrrolidone tribromide bromination of 5,5-diphenylcyclohex-2-en-1-one (**5**), mp 112°. The latter was obtained by bromination–dehydrobromination of 3,3-diphenylcyclohexanone (**6**), mp 115°. This ketone resulted from hydroboration of 4,4-diphenylcyclohexene (**7**), mp 66.5°, using an oxidative work-up and followed by a Jones oxidation. Finally, the diphenyl olefin **7** could be obtained by Wolff–Kishner reduction of 4,4-diphenylcyclohexenone.

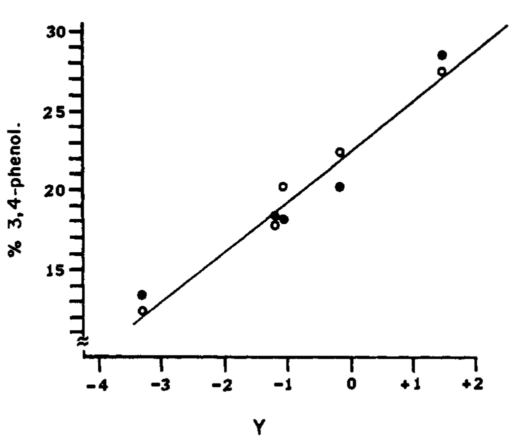

Figure 1. Plot of per cent 3,4-diphenylphenol obtained in dark and photochemical runs *vs.* *Y* values: ●, photochemical; ○, dark.

Potassium *tert*-butoxide treatment of 6-bromo-5,5-diphenylcyclohex-2-en-1-one (**1**) in *tert*-butyl alcohol at room temperature for 6 hr gave in 86% yield a mixture of 2,3-diphenylphenol (**2**) and 3,4-diphenylphenol (**3**). The ratio of phenols was analyzed by three methods: vpc on 5% SE-30 on Varaport 30, quantitative infrared analysis, and chromatographic separation and isolation.

These are the same two phenols obtained from the photolysis of 6,6-diphenylbicyclo[3.1.0]hex-3-en-2-one (**4**).[2,7] Strikingly, the ratio of the phenols obtained in the base-catalyzed treatment of bromo ketone **1** was identical with that from the photolysis.

Furthermore, the photolysis in different solvents was found to give a distribution of phenols which was a smooth, nearly linear function of solvent polarity as measured by *Y* value[8] as shown in Figure 1 and in Table I. It was found that the percentage of 3,4-diphenylphenol (**3**) increased with solvent polarity.

Table I. Distribution[a] of Phenols from Zwitterion

Solvent	Photochemical 3,4-diphenylphenol, %	Dark reaction 3,4-diphenylphenol, %	*Y*
tert-Butyl alcohol[b]	13.6 ± 2.5^{e}	12.4 ± 1.0^{d}	-3.3^{f}
95% ethanol-water[c]	18.4 ± 1.0^{d}	17.6 ± 1.0^{d}	-1.3^{f}
80% *tert*-butyl alcohol-water[c]	18.0 ± 2.5^{e}	20.4 ± 2.5^{e}	-1.1^{g}
73% dioxane-water[c]	20.2 ± 2.5^{e}	22.6 ± 2.5^{e}	-0.2^{g}
50% dioxane-water[c]	28.5 ± 1.0^{d}	27.5 ± 1.0^{d}	$+1.4^{f}$

[a] Tabulating the percentage of 3,4-diphenylphenol in the mixture of 2,3-diphenylphenol and 3,4-diphenylphenol. [b] Potassium *tert*-butoxide used as a base. [c] Potassium hydroxide used as a base. [d] Vpc analysis. [e] Quantitative infrared analysis—vpc analysis not performed. [f] Values of Winstein.[8] [g] Values not reported in the literature—obtained using the observation of W. H. Cropper, F. Spieth, and A. R. Olson (*J. Amer. Chem. Soc.*, **76**, 6248 (1954)) that the plot of *Y vs.* per cent water is linear in the region of low percentages of water.

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[1] For paper LXV of the series, note H. E. Zimmerman and D. S. Crumrine, *J. Amer. Chem. Soc.*, **94**, 498 (1972).

[2] (a) H. E. Zimmerman, 17th National Organic Chemistry Symposium, Bloomington, Ind., June 1961, Abstracts, p 31; (b) H. E. Zimmerman and D. I. Schuster, *J. Amer. Chem. Soc.*, **83**, 4486 (1961); (c) *ibid.*, **84**, 4527 (1962).

[3] H. E. Zimmerman and D. S. Crumrine, *ibid.*, **90**, 5612 (1968).

[4] (a) H. E. Zimmerman, *Advan. Photochem.*, **1**, 183 (1963); (b) H. E. Zimmerman, *Angew. Chem., Int. Ed. Engl.*, **8**, 1 (1969).

[5] H. E. Zimmerman and J. O. Grunewald, *J. Amer. Chem. Soc.*, **89**, 5163 (1967).

[6] Synthetic details will be given in our full paper. All compounds analyzed satisfactorily.

[7] H. E. Zimmerman, R. Keese, J. Nasielski, and J. S. Swenton, *J. Amer. Chem. Soc.*, **88**, 4895 (1966).

[8] (a) E. Grunwald and S. Winstein, *J. Amer. Chem. Soc.*, 70, 846 (1948); (b) S. Winstein, E. Grunwald, and H. W. Jones, *ibid.*, **73**, 2700 (1951); (c) A. H. Fainberg and S. Winstein, *ibid.*, **78**, 2770 (1956).