

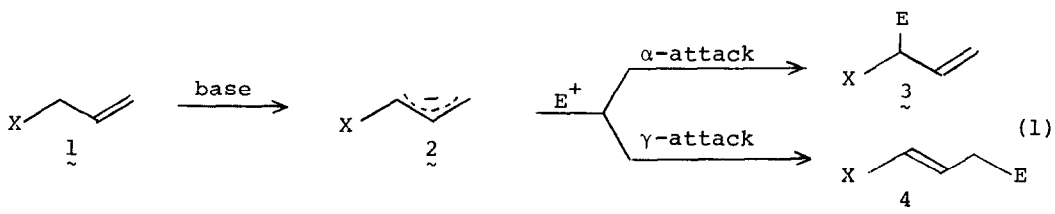
REACTIONS OF ALLYLPYRROLIDINE CARBANIONS WITH ELECTROPHILES.
A NEW HOMOENOLATE EQUIVALENT

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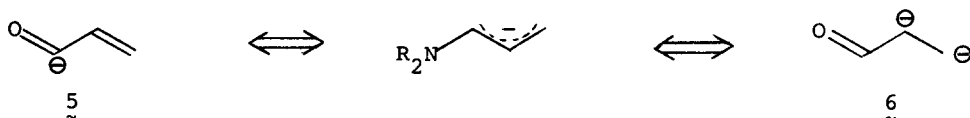
Although the allyl anions of a variety of 3-heterosubstituted propenes such as allyl ethers (1, X = OR, OSiR₃),² allyl thioethers (1, X = SR, SAR),³ and some N-arylallyl amines (1, X = NR₁R, NR₂)⁴ have been successfully generated and utilized as β-acyl carbanion equivalents (eq 1), there has been



no report of the preparation and the reactions of the anions of simple dialkylallyl amines (1, X = NR₂).⁵ Indeed, one previous attempt to metalate a dialkylallyl amine failed.^{4e}

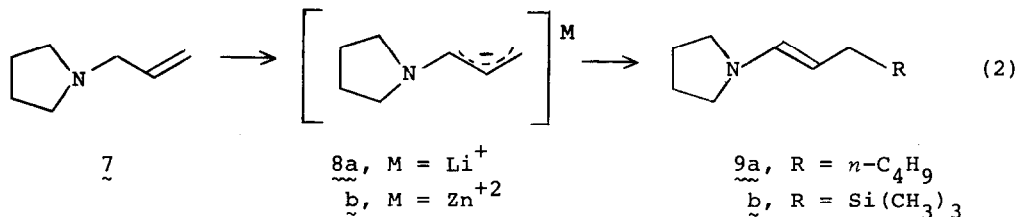
This is an unfortunate state of affairs indeed because the products obtained upon reaction of 2 (X = NR₂) with electrophiles would be especially interesting. For example, the α-substituted allyl amine 3 (X = NR₂), which would result from the attack of the electrophilic reagent at the α-carbon of the anion 2 (X = NR₂), might be oxidized⁶ to an α,β-unsaturated ketone rendering the allyl anion 2 a synthon for the anion 5. Alternatively, if the anion 2 (X = NR₂) reacted with an electrophile at the γ carbon, the enamine 4 (X = NR₂), a versatile synthetic intermediate which could be used in subsequent reactions with other electrophiles, would be produced. In this case, the allyl anion 2 (X = NR₂) is the synthetic equivalent of the dianion 6. In the first step toward the realization of these synthetic objectives, we now wish

to report the successful generation of the heretofore unknown allyl anion 2,

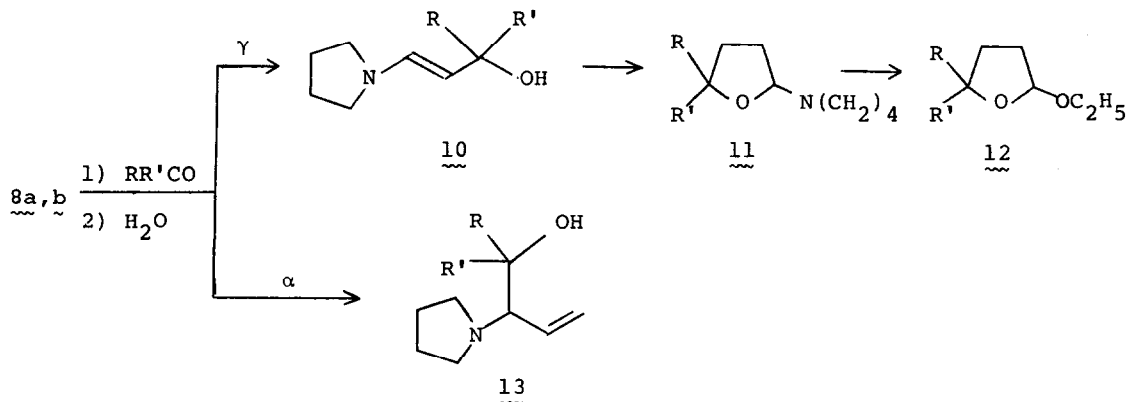


$X = N(CH_2)_4$, together with some of the reactions of this anion with electrophiles.

Allylpyrrolidine (7) may be conveniently metalated with *sec*-butyllithium in THF at -10° . When the allyl anion 8a thus produced was allowed to react at -78° with alkyl halides such as *n*-butylbromide or with chlorotrimethylsilane, the γ products 9a and 9b,⁷ respectively, were isolated in good yields (eq 2).



The *trans* olefin geometry follows from the 14 Hz coupling of the vicinal vinyl protons in the NMR of 9b. However, the reactions of the allyl anion 8a with aldehydes and ketones at -78° , produced mixtures that consisted of approximately equal amounts of 11, the cyclization products of the initially formed



γ adducts 10, and the α adducts 13.⁷ When these mixtures of 11 and 13 were treated with ethanolic hydrogen chloride, pure 13 along with the lactals 12 could be isolated.

The γ/α regioselectivity in the reactions of the allylpyrrolidine carbanion with carbonyl partners was also found to be dramatically counterion dependent.⁸ While, for example, the lithiated allyl anion 8a reacted with cyclohexanone to give approximately equal amounts of 11 and 13 ($\gamma:\alpha = 45:55$), the zinc reagent 8b reacted with cyclohexanone with a high degree of selectivity favoring the α -adduct 13 ($\gamma:\alpha = 5:95$).

The following general experimental procedure is representative of this conversion. To a solution of allylpyrrolidine (7) (1.2 equiv) in anhydrous THF under dry nitrogen at -78° was added *sec*-butyllithium (2.4 equiv). After the completion of this addition, the yellow mixture was allowed to warm to -10° and stirred at -10° for an additional 2 hr, whereupon the solution of the allylpyrrolidine anion 8a was again cooled to -78° . A solution of the appropriate electrophile (1.0 equiv) in anhydrous THF was added, and the stirring was continued at room temperature for 1 hr. The enamines 9a and 9b were then isolated by flash distillation, whereas the carbonyl adducts 11 and 13 were isolated following an aqueous work-up.⁷

Table. Reactions of Allylpyrrolidine Carbanions with Electrophiles

Anion	Electrophile	$\gamma:\alpha$ Ratio ^a	Product(s) Isolated ^b	% Yield Isolated ^c
<u>8a</u>	<i>n</i> -C ₄ H ₉ Br	>95:5	<u>9a</u> ^{d,e}	50
<u>8a</u>	(CH ₃) ₃ SiCl	>95:5	<u>9b</u> ^e	70
<u>8a</u>	<i>c</i> -C ₆ H ₁₁ CHO	50:50	<u>11</u> + <u>13</u>	64
<u>8a</u>	C ₆ H ₅ CHO	46:54	<u>11</u> + <u>13</u>	48
<u>8a</u>	CH ₃ COCH ₃	43:57	<u>11</u> + <u>13</u> ^f	59
<u>8a</u>	C ₆ H ₅ COCH ₃	40:60	<u>11</u> + <u>13</u>	74
<u>8a</u>	(CH ₂) ₅ CO	45:55	<u>11</u> + <u>13</u> ^f	71
<u>8b</u>	(CH ₂) ₅ CO	5:95	<u>13</u> ^g	42

^aDetermined by GLC and/or NMR; ^b Product 13 fully characterized and product 11 characterized as the lactal 12 unless otherwise noted; ^cTotal isolated yield based upon electrophile but not optimized; ^d Product characterized as 2,4-dinitrophenylhydrazone; ^eOnly γ product isolated; ^fBoth α and γ products fully characterized; ^gOnly α product isolated.

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References and Notes

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5. N,N-Dialkylynamines have, however, been successfully metalated and used as nucleophiles. See E. J. Corey and D. E. Cane, J. Org. Chem., 35, 3405 (1970).
6. *Cf.*, E. J. Corey, D. E. Cane and L. Libit, J. Am. Chem. Soc., 93, 7016 (1971).
7. All compounds were adequately characterized by spectral methods (IR, NMR, and MS), and all new compounds have satisfactory high resolution mass spectral and/or combustion analytical data.
8. For a similar example of the counterion dependency in the reactions of metalated allylic ethers with ketones see reference 2a.