

CYCLOADDITION REACTION OF 2-PHENYL-1-AZIRINE WITH AZIRIDINES¹⁾

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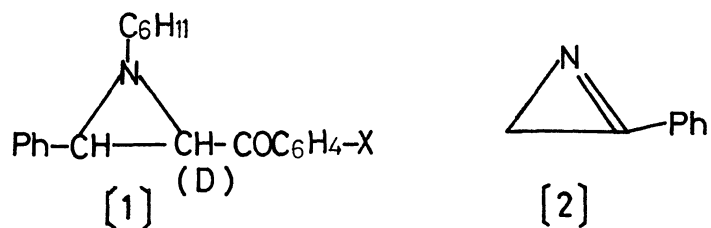
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A 1,3-dipolar reaction of 2-phenyl-1-azirine with a variety of aziridines afforded a novel type of heterocyclic compounds in excellent yield and thus the anomalously high dipolarophilic reactivity of 1-azirine was confirmed.

One of the authors has recently explored synthetic application of cycloaddition of aziridine to form new five membered heterocyclic compound.²⁾ 1-Azirine was found to be a potentially useful precursor to other heterocycles. The dipolarophilic character of 1-azirine has been overlooked and therefore it seems to be desirable to report briefly our results.

Refluxing of 2-benzoyl-1-cyclohexyl-3-phenylaziridine [1] with five molar amounts of 2-phenyl-1-azirine [2] in dry benzene under N₂ afforded, after usual work up, a mixture of two isomeric cycloadducts³⁾ in 77% yield which could be separated by preparative thin layer chromatography (PTLC) and each configuration of which was tentatively assigned as [3; X=H] and [4; X=H] by their pmr spectra; it is well documented,⁴⁾ that a ring proton is shielded by *cis-vic*-phenyl or stereochemically proximate phenyl and thus the H_d resonance appears at higher field in [4] than in [3], while the H_a and H_b resonances appear at higher field in [3] than in [4]. A series of similar adducts were obtained by the reaction of 2-phenyl-1-azirine with various



2-arylaziridines, physical properties of which and relative ratios of [3] and [4] are summarized in Table 1.

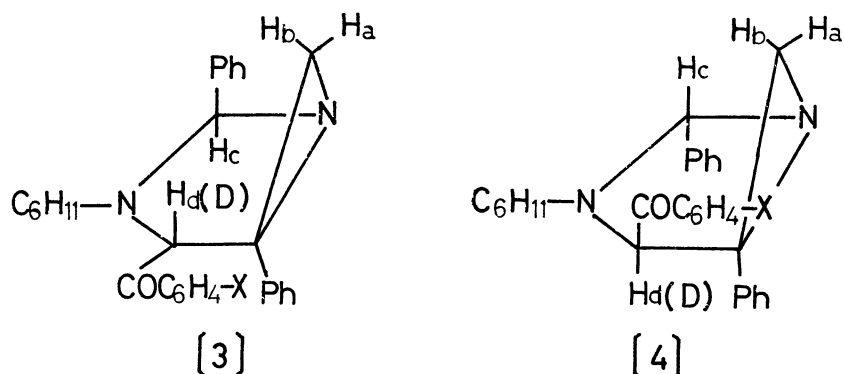


Table 1. Physical Properties of the Cycloadducts⁵⁾ obtained by the Reaction of 2-Phenyl-1-azirine with 2-Arylaziridines

X	mp (°C)	Yield(%)	ir(cm ⁻¹) (C=O)	pmr($\delta_{\text{CDCl}_3}^{\text{TMS}}$)*)				[4]/[3]
				H _a	H _b	H _c	H _d	
p-CH ₃ O	[3]	81	1670	1.26	2.82	5.69	6.11	1.7
	[4]			1.96	3.17	5.26	5.13	
p-CH ₃	[3]	73	1666	1.48	2.90	5.94	6.21	1.6
	[4]		1677	2.00	3.25	5.47	5.37	
H	[3]	77	1655	1.44	2.79	5.66	6.04	1.3
	[4]		1665	1.94	3.10	5.43	5.26	
p-Cl	[3]	80	1673	1.52	2.91	5.76	6.21	0.93
	[4]		1680	2.04	3.19	5.56	5.42	
p-NO ₂	[3]	74	1686	1.55	2.85	5.63	6.04	0.61
	[4]		1687	2.05	3.02	5.43	5.32	

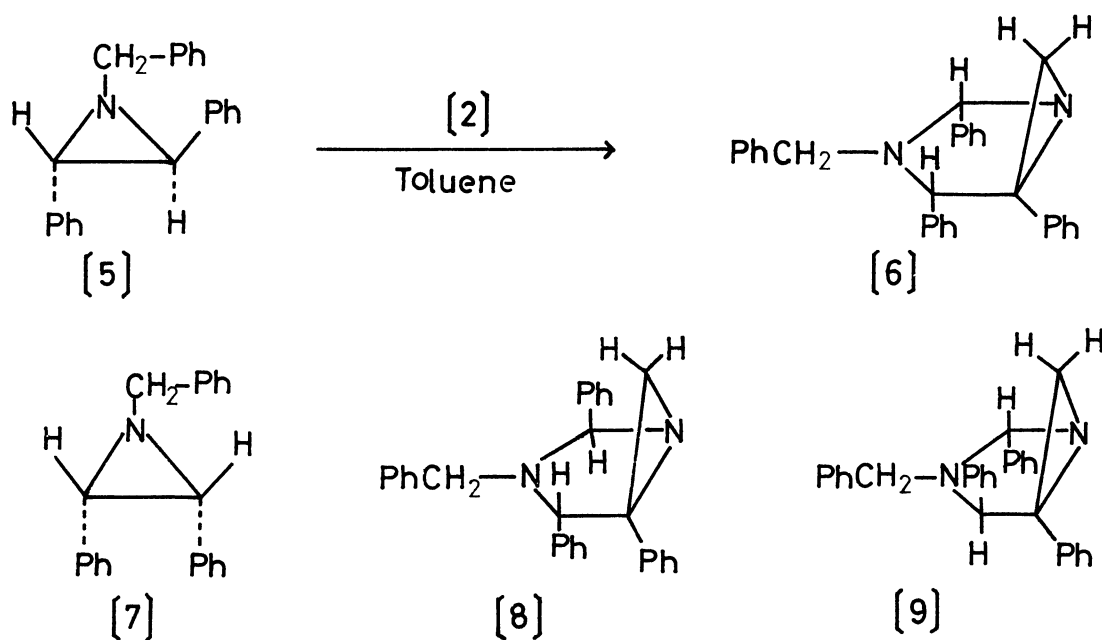
*) All adducts showed absorption in the appropriate region due to aromatic and cyclohexyl protons with the corresponding integration.

**) A mixture of two isomers, which could not be separated by PTLC because of the instability of the adducts on silica gel.

Reaction of [2] with stereochemically pure samples of *cis*- and *trans*-2-arylaziridine gave the mixture of two isomeric adducts in approximately the same yield in the same relative ratio.⁶⁾ Partial unambiguous assignment of pmr spectra (H_d) was made using specific deuterium labeling; reaction of 2-benzoyl-2-deuterio-1-cyclohexyl-

3-phenylaziridine (51 % labeled) gave a mixture of [3 ; X=H] and [4 ; X=H], pmr spectra of which showed the singlets (intensity; ca. 0.5H) at $\delta=6.04$ and 5.26, respectively.

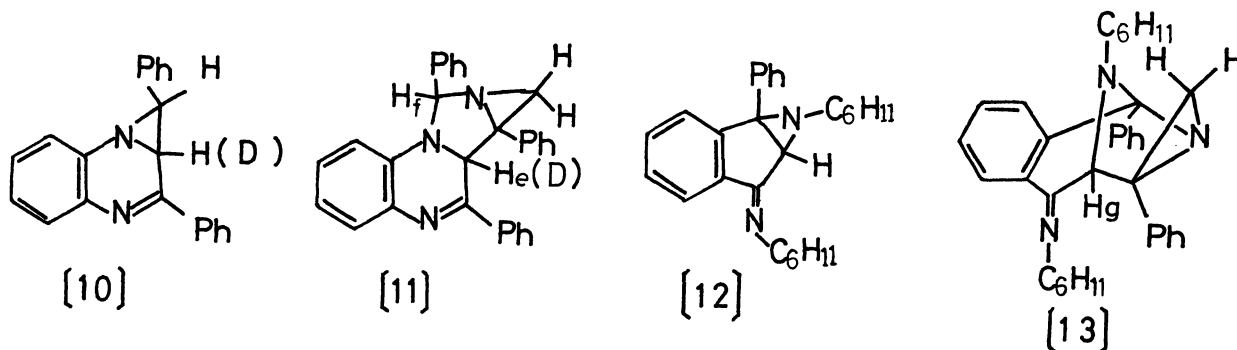
Reaction of *trans*-1-benzyl-2,3-diphenylaziridine [5]⁷⁾ with [2] in refluxing toluene, on the other hand, gave only one adduct [6]⁵⁾ in 78 % yield; mp 137-138°C, pmr($\delta_{\text{CDCl}_3}^{\text{TMS}}$): 1.48(1H, s), 2.98(1H, s), 3.68(2H, s), 4.09(1H, s), 4.93(1H, s), 6.8~8.0(20H, m). A similar reaction of *cis*-1-benzyl-2,3-diphenylaziridine [7]⁷⁾ with [2] afforded the two isomers [8]⁵⁾ (38 % yield): mp 209-210°C, pmr($\delta_{\text{CDCl}_3}^{\text{TMS}}$): 1.54(1H, s), 3.16(1H, s), 2.83 and 3.60(2H, ABq, J=15 Hz), 5.05(1H, s), 5.29(1H, s), 6.9~8.0(20H, m), and [9]⁵⁾ (34 % yield); mp 168-169°C, pmr($\delta_{\text{CDCl}_3}^{\text{TMS}}$): 2.07(1H, s), 3.30(1H, s), 2.94 and 3.61(2H, ABq, J=15 Hz), 4.48(1H, s), 5.05(1H, s), 7.0~7.8(20H, m). The smooth cycloaddition and stereospecificity observed are rather surprising be-



cause of the reported sluggish dipolarophilic activity of Ph-CH=N-Ph.⁸⁾ The anomalously high dipolarophilic reactivity of [2] might be ascribed to the highly angular strained and thus energy-rich double bond.

The bicyclic aziridine [10] also underwent smoothly 1,3-cycloaddition to [2] to give the polycyclic system [11]⁵⁾ (91 % yield); mp 192-193°C, pmr($\delta_{\text{CDCl}_3}^{\text{TMS}}$): 1.88 (1H, s), 2.02(1H, s), 5.32(1H, s), 5.80(1H, s), 6.3~7.9(14H, m), and when [2] was reacted with the deuterated aziridine (63 % labeled), pmr spectrum of the adduct showed a singlet, intensity of which was 0.6H, at $\delta=5.32$. Interestingly, 1-cyclohexyl-6-(cyclohexylimino)-1,1a,6,6a-tetrahydro-1a-phenylindeno[1,2-b]azirine [12], which had failed to cycloadd with any heteromultiple dipolarophile,⁹⁾ reacted with [2] to

afford the cycloadduct [13]^{3,5)} in 89 % yield; mp 166-167°C, pmr($\delta_{\text{CDCl}_3}^{\text{TMS}}$): 0.5~2.1 (20H, m), 2.4~2.8(1H, m), 2.9~3.5(1H, m), 2.11(1H, s), 3.16(1H, s), 5.21(1H, s), 6.8~8.5(14H, m), ir(KBr): 1635 cm^{-1} (-N=C). If the orientation assumed above is reversed, H_e resonance in [11] and H_g resonance in [13] will appear at lower field than H_f in [11] because of deshielding by two adjacent nitrogen atoms and C=N group.



Attempts to make a chemical transformation of these adducts obtained to other heterocycles and further reaction of 1-azirine with miscellaneous dipolar species are currently under investigation in our laboratory.

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- 3) The orientation of the adducts described may be reasonable since the regio-specificity of the cycloaddition of the unsymmetrical aziridines is well established²⁾ and the results of pmr data are consistent with those of the reported imidazolidines,⁸⁾ although unambiguous assignment of the orientation using 2-unsubstituted-1-azirine as a dipolarophile could not be achieved in the present time because of the thermal instability of 2-unsubstituted-1-azirine.
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- 7) R. Huisgen and K. Matsumoto, to be published.
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