CHEMISTRY LETTERS, pp. 759-762, 1973. Published by the Chemical Society of Japan

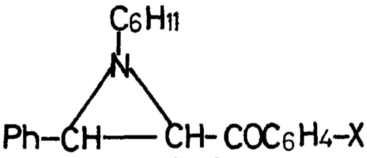
CYCLOADDITION REACTION OF 2-PHENYL-1-AZIRINE WITH AZIRIDINES[1)]

Kiyoshi MATSUMOTO* and Kazuhiro MARUYAMA**
*Department of Chemistry, Colledge of Liberal Arts and
Science, Kyoto University, Sakyo-ku, Kyoto 606
**Department of Chemistry, Faculty of Science, Kyoto University,
Sakyo-ku, Kyoto 606

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.

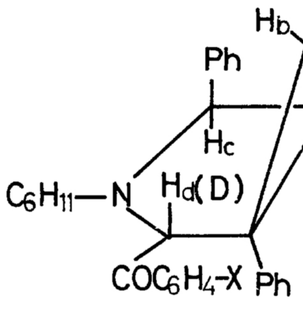
Refluxing of 2-benzoyl-1-cyclohexyl-3-phenylaziridine[1] with five molar amounts of 2-phenyl-1-azirine[2] in dry benzene under N_2 afforded, after usual work up, a mixture of two isomeric cycloadducts[3)] in 77% yield which could be separated by preparative thin layer chromatography(PTLC) and each configuration 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



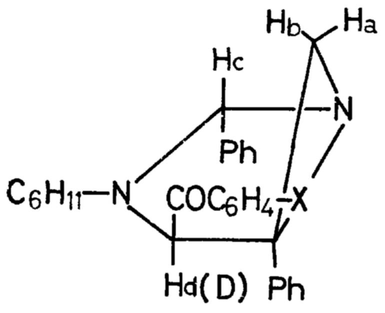
[1]

[2]

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



[3]



[4]

Table 1. Physical Properties of the Cycloadducts[5)] obtained by the Reaction of 2-Phenyl-1-azirine with 2-Aroylaziridines

X		mp (°C)	Yield(%)	ir(cm^{-1}) (C=O)	pmr($\delta^{TMS}_{CDCl_3}$)*)				[4]/[3]
					H_a	H_b	H_c	H_d	
p-CH_3O	[3]	134-136**)	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]	185-186	73	1666	1.48	2.90	5.94	6.21	1.6
	[4]	167-168		1677	2.00	3.25	5.47	5.37	
H	[3]	213-214	77	1655	1.44	2.79	5.66	6.04	1.3
	[4]	117-118		1665	1.94	3.10	5.43	5.26	
p-Cl	[3]	199-200	80	1673	1.52	2.91	5.76	6.21	0.93
	[4]	131-132		1680	2.04	3.19	5.56	5.42	
p-NO_2	[3]	224-225	74	1686	1.55	2.85	5.63	6.04	0.61
	[4]	132-133		1687	2.05	3.02	5.43	5.32	

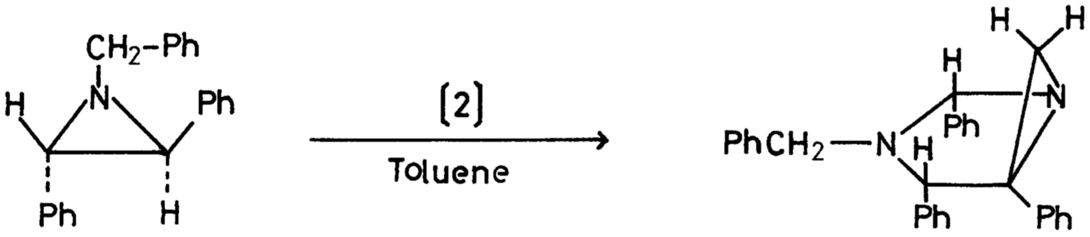
*) All adducts showed absorption in the appropriate region due to aromatic and cyclohexyl protons with the corresponding integration.

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

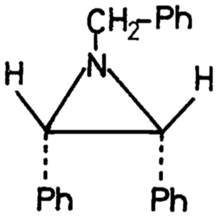
Reaction of [2] with stereochemically pure samples of *cis*- and *trans*-2-aroylaziridine gave the mixture of two isomeric adducts in approximately the same yield in the same relative ratio.[6)] Partial unambiguous assignment of pmr spectra (H_d) was made using specific deuterium labeling; reaction of 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 δ=6.04 and 5.26, respectively.

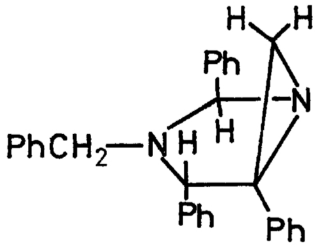
Reaction of *trans*-1-benzyl-2,3-diphenylaziridine[5]7) with [2] in refluxing toluene, on the other hand, gave only one adduct[6]5) in 78 % yield; mp 137-138°C, pmr($\delta^{TMS}_{CDCl_3}$): 1.48(1H, s), 2.98(1H, s), 3.68(2H, s), 4.09(1H, s), 4.93(1H, s), 6.8∿8.0(20H, m). A similar reaction of *cis*-1-benzyl-2,3-diphenylaziridine[7]7) with [2] afforded the two isomers [8]5)(38 % yield): mp 209-210°C, pmr($\delta^{TMS}_{CDCl_3}$): 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($\delta^{TMS}_{CDCl_3}$): 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 surprizing because 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.



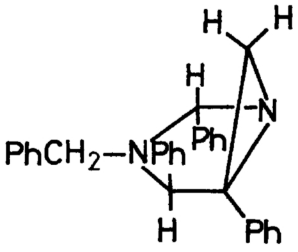
[5] [6]



[7]

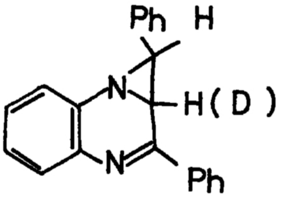


[8]

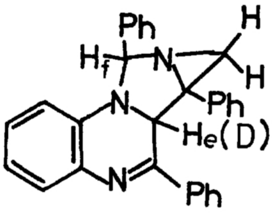


[9]

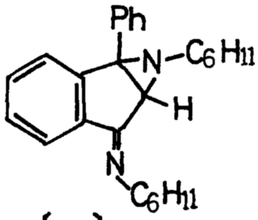
The bicyclic aziridine[10] also underwent smoothly 1,3-cycloaddition to [2] to give the polycyclic system[11]5)(91 % yield); mp 192-193°C, pmr($\delta^{TMS}_{CDCl_3}$): 1.88 (1H, s), 2.02(1H, s), 5.32(1H, s), 5.80(1H, s), 6.3∿7.9(14H, m), and when [2] was reacted with the deuterated aziridine(63 % labeled), pmr spectrum of the adduct showed a singlet, intensity of which was 0.6H, at δ=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($\delta^{TMS}_{CDCl_3}$): 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.



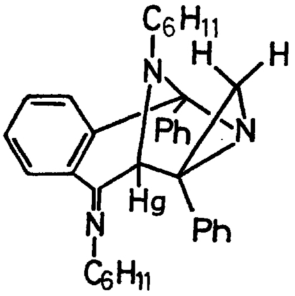
[10]



[11]



[12]



[13]

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.

REFERENCES

1) Reaction of Strained Molecules. II.

2) J. W. Lown and K. Matsumoto, Yuki Gosei Kagaku Kyokai Shi, 29, 760 (1971).

3) The orientation of the adducts described may be resonable since the regiospecificity of the cycloaddition of the unsymmetrical aziridines is well established$^{2)}$ 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.

4) R. Sustmann, R. Huisgen, and H. Huber, Chem. Ber., 100, 1802 (1967).

5) Satisfactory analytical data were obtained on all new compounds.

6) *cis*- and *trans*-2-Aroylaziridines cycloadd with dipolarophiles, in general, via *trans*-azomethine ylide which might be more stable.

7) R. Huisgen and K. Matsumoto, to be published.

8) J. W. Lown, J. P. Moser, and R. Westwood, Can. J. Chem., 47, 4335 (1969).

9) J. W. Lown and K. Matsumoto, J. Org. Chem., 36, 1405 (1971).

(Received May 14, 1973)