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CYCLOADDITION REACTIONS OF VINYL AZIDES AND β-IODO AZIDES WITH ACETYLENIC ESTERS

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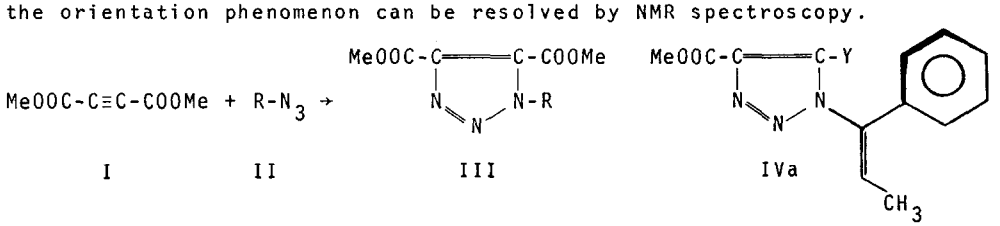
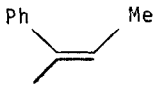
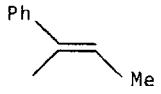
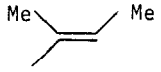
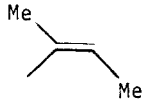
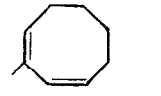
A general problem encountered in the study of cycloadditions of azides with monosubstituted acetylenes is the elucidation of the regiochemistry[1] of the reaction, that is the extent of formation of 1,4- or 1,5- disubstituted triazoles. Many investigators in this field left the question unanswered or predicted the structure on the basis of theoretical considerations.[2] In the case of aryl azides, and to a lesser extent alkyl azides, the problem can be resolved by comparison of the cycloadduct with an authentic sample prepared from an active methylene compound by the Dimroth method.[3] This identification method, however, fails for acyl azides, azidoformates and sulfonyl azides.[4] In our study on the cycloaddition reactions of vinyl azides with acetylenic esters we have found that the orientation phenomenon can be resolved by NMR spectroscopy.



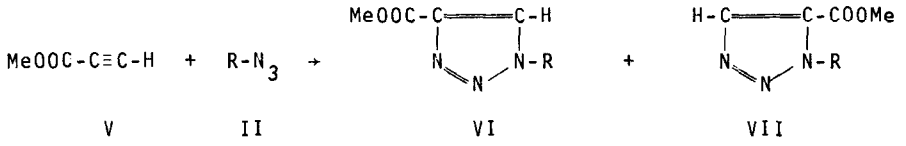
I II III IVa

Our attention was drawn to the observation that the cycloadducts IIIa-i, obtained from dimethyl acetylenedicarboxylate I and the vinyl azides IIa-e or the β-iodoalkyl azides[5] IIf-i give rise to two distinct methyl ester absorptions in the NMR spectra (in $CDCl_3$) as shown in Table 1. IIIa and IIIb however show a more striking effect than all the other triazoles, whose origin must be found in the shielding by the phenyl ring current, of the methyl ester function in the 5-position (see conformation IVa where Y = CO_2CH_3).

TABLE 1. 1-SUBSTITUTED-4,5-DICARBOMETHOXY-1,2,3-TRIAZOLES III.

	Substituent R	NMR (τ) values of Me ester functions	yield (isolated) %	m.p. (recryst. solvent)
a		6.07 and 6.36	70	88-90°(pet. ether)
b		6.12 and 6.34	37*	
c		6.03 and 6.08	80	58-60°(CCl_4-pentane)
d		6.03 and 6.05	72	36.5-37.5°(ether-pentane)
e		6.09 and 6.14	40	76-78°(diisopropyl ether)
f	-CH(Ph)-CH(I)-Me(erythro)	6.02 and 6.06	90	131-134°(benzene-pet.ether)
g	-CH(Ph)-CH(I)-COPh(erythro)	5.98 and 6.11	80	155-156°(CCl_4)
h	-CH(Ph)-CH(I)-CO_2Me(erythro)	6.00 and 6.03	71	103-105°(CCl_4)
i	-CH_2-CHI-tBu	6.00 and 6.03	86	99-99.5°($CHCl_3$pet. ether)

This yield was based on starting olefin (cis-β-methyl styrene) from which the vinyl azide was prepared.[5]



V II VI VII

On the basis of this shielding effect, we were able to distinguish between VI and VII when the azides IIj-q were treated with methyl propiolate V. The NMR spectra (in $CDCl_3$) of the crude reaction mixtures showed the presence of two isomeric triazoles in a ratio of about 80/20 (90/10 in the case of IIp), based on the triazole =C-H signals. The major =C-H peak in the NMR spectra is attributed to the 1,4-isomer because it is shifted upfield by more than 10 cps when IIj and IIk are substituted for IIm-q while the minor =C-H peak remains almost at the same position (see Table 2). This shielding by the phenyl group is expected for the proton in the 5-position of VIj and VIk (see conformation IVa where Y = H). In addition VIk, isolated from the reaction mixture, exhibits a methyl ester absorption at τ6.07 indicating the absence of a shielding effect from the phenyl group. Its isomer VIIk, isolated by preparative thin layer chromatography, shows a methyl ester absorption at τ6.35. The results are consistent with the general observation that electron-withdrawing substituents prefer to locate in the 4-position of the cycloadducts.[6]

The reactions described in this paper were carried out at room temperature by mixing equimolecular amounts of the two reagents. The yields and m.p. of the isolated III and VI are given in Tables 1 and 2. Although there is a substantial literature on vic-triazoles, the examples listed here are the first reported 1-vinyl-1,2,3-triazoles. The triazoles derived from the β-iodo azides can be transformed into the vinyltriazoles by treatment with sodium methoxide or triethylenediamine. Furthermore, the readily isolable triazole solids, III, are most useful in the characterization of vinyl azides or iodo azides[5] which, due to their lability, are sometimes extremely difficult to purify.

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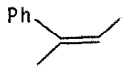
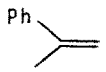
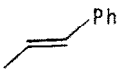
TABLE 2: 1,2,3-TRIAZOLES VI AND VII

	Substituent R	NMR (τ) values of the triazole protons		Triazole VI (isolated)	
		major isomer (1,4-)	minor isomer (1,5-)	yield%	m.p.(recryst. solvent)
j		2.04	1.86	-*	
k		1.87	1.80	62	73-73.5°(ether)
m		1.60	1.82	44	178-179°($CHCl_3$)
n		1.68	1.87	67	118-119°(ether)
p	PhCH-CH_2I	1.72	1.86	51	166-167°($CHCl_3$-CCl_4)
q	-CH_2-CHI-tBu	1.65	1.85	62	148-149.5°(ethanol)

*Could not be isolated in crystalline form.

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6. Review: G. L'abbé, Chem. Rev., *69*, 345 (1969).