

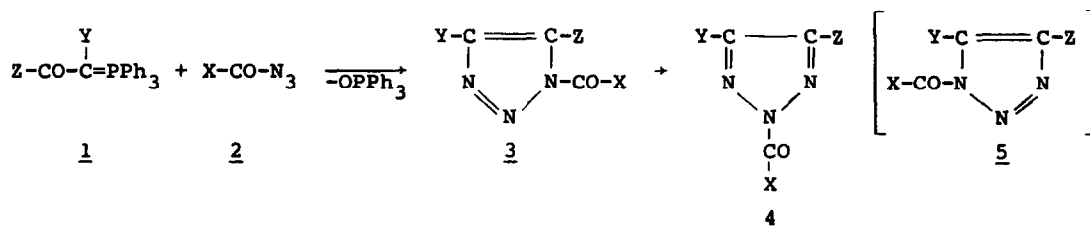
REACTIONS OF α -KETO- AND α -ESTER PHOSPHORUS YLIDES WITH CARBONYL AZIDES.
ISOMERIZATION OF THE REACTION PRODUCTS.

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During the course of our investigation of the synthesis of *vic*-triazoles by reacting α -keto- and α -ester phosphorus ylides with acyl azides and ethyl azidoformate (1 + 2 \rightarrow 3), we found that the N-1 substituted triazoles isomerized to the N-2 substituted triazoles (3 \rightarrow 4) under the basic reaction conditions. A description of this phenomenon is the subject of this communication.



When the reactions of 1 with 2 were carried out in NMR tubes, and the spectra recorded at different stages of the overall conversion, the N-1 substituted triazoles 3 were observed first, but then disappeared in favor of the N-2 substituted triazoles 4 as the reaction progressed. The NMR data are summarized in table 1, and the following criteria were used to distinguish between both isomeric structures 3 and 4:

- 1°) When Y = H and Z = Me, both substituents exhibit a coupling constant of about 1 Hz for 3, and less than 0.15 Hz in the case of 4.¹
- 2°) Considering the anisotropy of the carbonyl group, a methyl group in the 5-position of 3 is deshielded with respect to 4.²
- 3°) When Z = Ph (and Y = H), the phenyl protons give rise to a singlet absorption in 3, and to two multiplets in 4.³

Significantly, the reaction of acetylethylidenetriphenylphosphorane (1, Y = Z = Me) with *m*-nitrobenzoyl azide (2, X = *m*-NO₂C₆H₄) led to an isomerized product (4d) which exhibited only one methyl singlet absorption at τ 7.60, accounting for both substituents Y and Z. This result provides conclusive evidence against

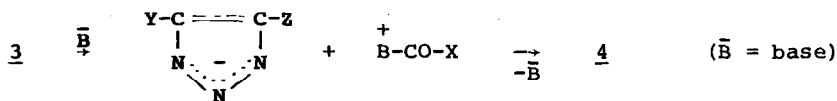
structure 5, which has been reported to result from thermal isomerization of triazoles of type 3.⁴

Table 1. NMR data of the Triazoles* (CDCl_3 , τ -values, s=singlet, m=multiplet).

	X	Y	Z	Triazole <u>3</u>		Triazole <u>4</u>	
				Y	Z	Y	Z
a)	CH_3	H	CH_3	2.50(q, 1Hz)	7.43(d, 1Hz)	2.25(s)	7.62(s)
b)	$\text{p-NO}_2\text{C}_6\text{H}_4$	H	CH_3		7.33(d, 1Hz)	2.15(s)	7.50(s)
c)	$\text{p-MeOC}_6\text{H}_4$	H	CH_3	2.45(q, 1Hz)	7.39(d, 1Hz)	2.30(s)	7.55(s)
d)	$\text{m-NO}_2\text{C}_6\text{H}_4$	CH_3	CH_3	7.64(s)	7.40(s)	7.60(s)	7.60(s)
e)	$\text{p-MeOC}_6\text{H}_4$	H	C_6H_5	2.19(s)	2.59(s)	1.77(s)	1.9-2.6(m)
f)	OC_2H_5	H	C_6H_5	2.33(s)	2.56(s)	1.80(s)	1.9-2.6(m)

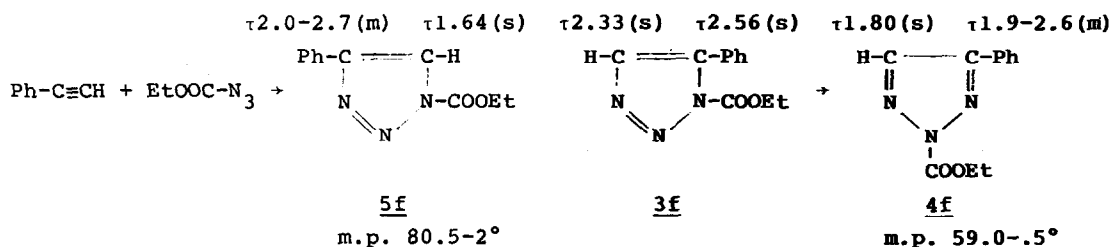
*The following triazoles were isolated by reacting equimolar amounts of 1 and 2 at room temperature (yields and m.p. are given): 4b, 65%, 147-8°; 4c, 24%, 51.5-3°; 4d, 79%, 140.5-2°; 3e, 81%, 121-3°; 4e, 81%, 103-4°; 4f, 46%, 59.0-.5°.

Mechanism. When the reactions of 1 with 2 were worked up prior to completion, some N-1 substituted triazoles 3 were isolated in good yield. This enabled us to study the isomerization process 3 \rightarrow 4 in more detail. 1-p-Methoxybenzoyl-5-phenyl-1,2,3-triazole (3e) remained unchanged when heated in CDCl_3 at 50° for 4 days, and addition of triphenylphosphine oxide to this solution had no effect. However, acyl migration did occur in the presence of acetylmethylenetriphenylphosphorane (1, Y = H, Z = Me) or other bases such as triethylamine and triethylenediamine. Furthermore, an equimolar mixture of 1-p-methoxybenzoyl-5-phenyl-1,2,3-triazole (3e) and 1-carbethoxy-5-p-nitrophenyl-1,2,3-triazole (3, X = OEt, Y = H, Z = $\text{p-NO}_2\text{C}_6\text{H}_4$, yield = 90%, m.p. 156-8°) in the presence of triethylenediamine precipitated the "cross product": 2-p-methoxybenzoyl-5-p-nitrophenyl-1,2,3-triazole (4, X = $\text{p-MeOC}_6\text{H}_4$, Y = H, Z = $\text{p-NO}_2\text{C}_6\text{H}_4$, m.p. 168-9.5°) in 95% yield, thus providing evidence for an intermolecular process. The following mechanism accounts for these observations:



A reconsideration of published data. In the light of the above results, structure 4 should be attributed to the previously reported products, isolated by reacting α -keto- and α -ester phosphoranes with acyl azides and ethyl azidoformate.⁵

Huisgen and Blaschke⁶ reported the reaction of ethyl azidoformate with phenylacetylene at 130° to give a mixture of an oxazole (16%) and a triazole (16%) of structure 5f or 3f. We are now able to exclude both proposed structures and to assign structure 4f to their product.⁷ Indeed, when ethyl azidoformate was allowed

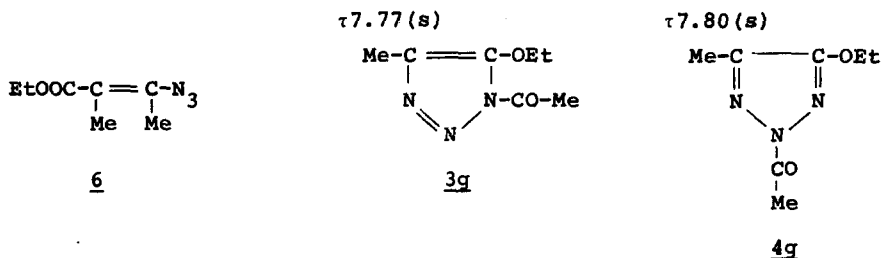


to react with phenylacetylene at 50° for 3 weeks, we observed by NMR that both isomers 5f and 3f were formed in a ratio of about 53/47% (overall yield 36%). On addition of triethylenediamine, this mixture isomerized to 4f, identical with the product isolated by the above authors. It is interesting to note that the sterically less stable 3f disappeared ca 1.7 times faster than 5f (see table 2).

Table 2. Isomerization of 5f and 3f into 4f as a function of time.

Time (min.)	% <u>5f</u>	% <u>3f</u>	% <u>4f</u>
0	53	47	-
55	48.5	42.3	9.2
155	44.6	28.5	26.9
220	37.3	19.7	43.0

Zbiral and Stroh⁴ have recently reported that carbethoxyethylidenetriphenylphosphorane (1, Y = Me, Z = OEt) undergoes a Wittig-reaction with acetyl azide to yield the *cis-trans* isomeric vinyl azides 6. Since this reaction is very unusual in view of our previous study with other carbonyl azides,⁵ we reinvestigated this particular case and found a different result. After complete reaction, no azide band was observed in the IR (in the region of 2120 cm⁻¹), thus eliminating the structure 6. When the reaction was followed by NMR, the only products observed were triphenylphosphine oxide and the triazoles 3g and 4g.



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Footnotes and References.

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6. R. Huisgen and H. Blaschke, *Chem. Ber.* 98, 2985 (1965).
7. It is also probable that thermal isomerization occurred in the experiments of Scarpatti et al (R. Scarpatti, M. L. Graziano and R. A. Nicolaus, *Gazz. Chim. Ital.* 99, 1339 (1969), and that their triazole, isolated from ketene dimethyl-acetal and ethyl azidoformate, has structure 4 instead of 3 (X = OEt, Y = H, Z = OMe).