4*H*-1,3-Oxazines, 4,5-Dihydro-oxazoles, and Thia Analogues from Hetero-1,3-dienes and 1-Alkynes†

Klaus Burger,* Erasmus Huber, Wolfgang Schöntag, and Ralph Ottlinger

Department of Organic Chemistry, Technical University of Munich, D-8046 Garching, Lichtenbergstrasse 4, W. Germany

4*H*-1,3-Oxazines (**3**) and/or 4,5-dihydro-oxazoles (**9,10**) and thia analogues are formed on reaction of alk-1-ynes with the 4,4-bis(trifluoromethyl)-1-oxa-3-azabuta-1,3-dienes (**1**) and 1-thia-3-azabuta-1,3-dienes (**4**), respectively.

1,3-Dienes and hetero-1,3-dienes (1=2–3=4) should react in cycloaddition reactions with multiple bond systems (5$\equiv$6) to give six,[1–3] five,[4,5] and four membered ring systems,[6,7] linking

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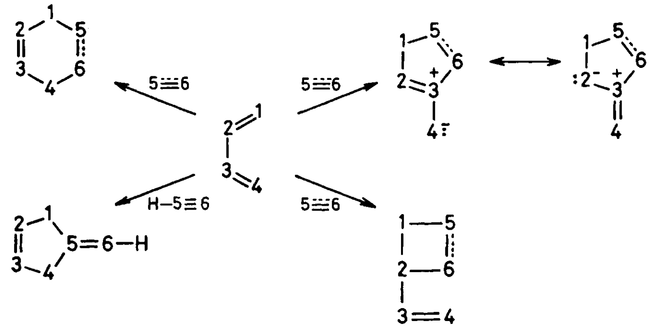
† Preliminary results were presented at the 6th Lakeland Heterocyclic Symposium of the Royal Society of Chemistry, Grasmere, Cumbria, May, 1983.



Scheme 1

four, three, or two atoms respectively from the diene, into a new ring system (Scheme 1).‡ Up to now cycloaddition reactions in which the dienophile skeleton is only partially incorporated into the ring system were unknown. In the present communication we report on the first examples of this new type of reaction.

At room temperature the hetero-diene (**1**; R^1=Ph)[8] reacted with phenylacetylene to give the Michael adduct (**2**), that could be transformed into the 4*H*-1,3-oxazine (**3**) on heating (Scheme 2).[9,10] When the thia-analogue (**4**; R^1=Ph)[11] was heated in phenylacetylene up to 80—90 °C two [1 : 1] adducts were formed. Comparison of the ^{13}C n.m.r. data§ with those recorded for the model compounds (**7**) and (**8**)[10] (see Table 1) confirmed the 4*H*-1,3-thiazine (**5a**) and 4,5-dihydrothiazole (**6a**) structures, respectively. A $^5J_{HF}$ coupling constant of *ca.* 1 Hz in (**6a**) indicated a (*Z*)-configuration for the exocyclic carbon–carbon double bond. Using *p*-chlorophenylacetylene as the dienophile the product ratio changed from 43 : 57 (**5a**) : (**6a**) to 27 : 73 (**5b**) : (**6b**).¶

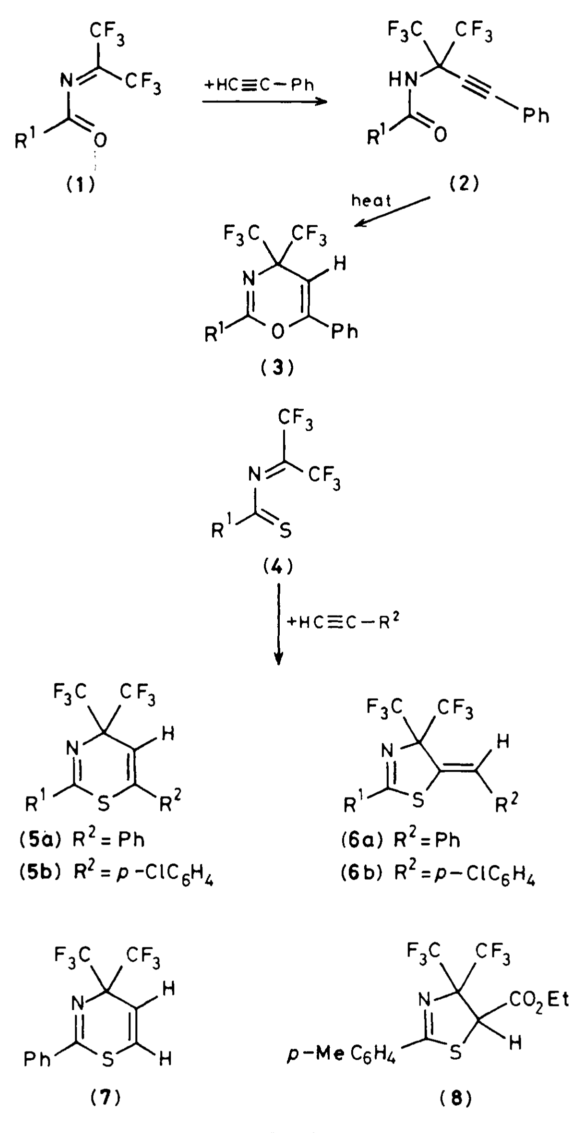
Compounds of type (**5**) should be formed *via* Michael addition, as in the case of the oxygen analogue (**3**). The formation of (**6**) involves a new cyclisation process. We propose the mechanism shown in Scheme 3.

Corresponding to the mechanism postulated, the tendency to yield five-membered ring systems on the reaction of hetero-1,3-dienes with alk-1-ynes should depend on the nucleophilicity of the terminal heteroatom of the diene and the electrophilicity of the carbon–carbon triple bond.

Table 1. M.p. and ^{13}C chemical shifts of compounds (3) and (5)—(13).

	R^1	X	M.p./°C	^{13}C N.m.r. data[a] δ(C-2)	δ(C-4)[b](*J*/Hz)
(3)	Ph	O	117	157.1	64.2 (29)
(5a)	Ph	S	65	164.8	70.9 (29)
(6a)	Ph	S	103	175.9	90.7 (28)
(7)	Ph	S	71	163.6	67.6 (29)
(8)	*p*-MeC_6H_4	S	61—62	176.7	90.4 (28)
(9)	Ph	O	99	169.5	81.0 (31)
(10)	Ph	O	99	167.1	81.5 (32)
(11)	*p*-MeC_6H_4	S	106	177.2	91.0 (29)
(12)	*p*-MeC_6H_4	S	112	173.2	89.5 (30)
(13)	Ph	S	119	164.7	70.8 (30)

[a] δ in p.p.m. relative to Me_4Si. [b] Septet for every compound.



Scheme 2. R^1 = Ph.

In reactions with methyl propiolate (**4**; R^1 = *p*-MeC_6H_4) gave two stereoisomeric 4,5-dihydrothiazoles, (**11**) (42%) and (**12**) (31%), and (**4**; R^1 = Ph) gave, in addition the [4 + 2] cycloadduct (**13**) (6%). As expected, five-membered ring formation clearly dominated over six-membered ring formation. However, yields, as well as isomer ratio, were strongly dependent on the reaction conditions used (Scheme 4).

Even treatment of (**1**; R^1 = Ph), possessing a considerably less nucleophilic terminal heteroatom than (**4**), with methyl propiolate gave 4,5-dihydro-oxazoles (**9**) and (**10**) in ⩾95% yield;** again the (*Z*)-isomer was the main product.

The reaction between hetero-1,3-dienes with a terminal heteroatom and electron-deficient carbon–carbon triple or double bond systems[12] with at least one hydrogen atom bonded directly to one of the unsaturated carbon atoms to form five-membered ring systems represents a new synthetic route to heterocyclic compounds. The reaction is not restricted to trifluoromethyl-substituted hetero-1,3-dienes, and its scope and limitations are being investigated.

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‡ The phenomena of regio- and site-selectivity are neglected in this scheme.

§ Recorded with a Jeol FX 100 instrument in $CDCl_3$ with $SiMe_4$ as internal standard.

¶ Determined by ^{19}F n.m.r. spectroscopy with a Jeol C 60 HL instrument operating at 56.45 MHz. Isolated yields: (**5a**) 34%, (**5b**) 21%, (**6a**) 46%, (**6b**) 56%.

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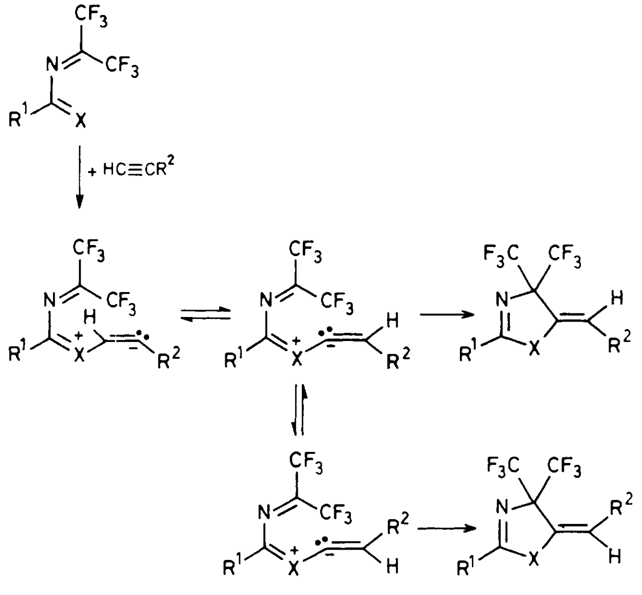

Scheme 3

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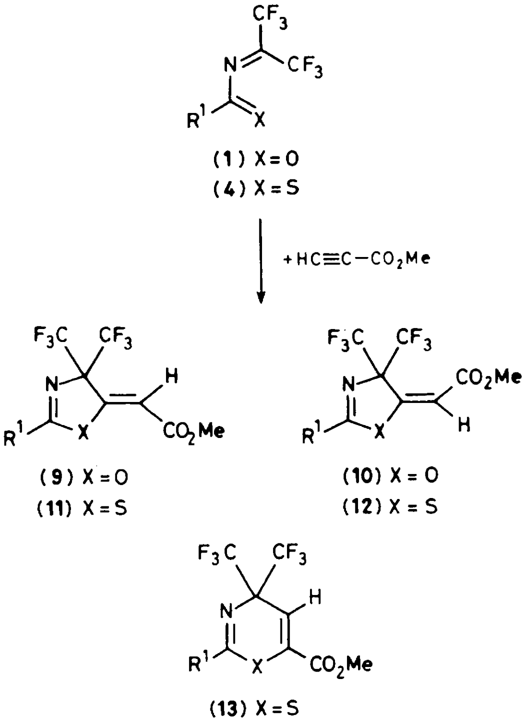

Scheme 4

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