RING TRANSFORMATIONS OF HETEROCYCLES 2[1]

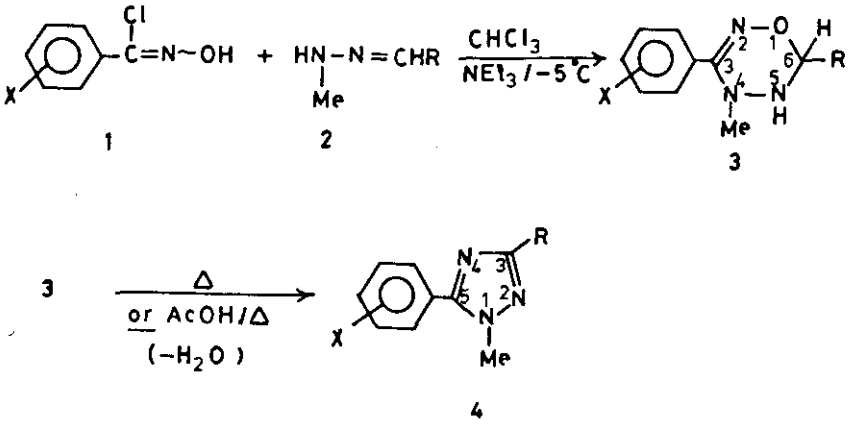
RING CONTRACTION OF 5,6-DIHYDRO-4H-1,2,4,5-OXATRIAZINES INTO 1H-1,2,4-TRIAZOLES

Mustafa M. El-Abadelah*, Ahmad Q. Hussein, Musa Z. Nazer, and Osama M. Musa
Chemistry Department, Faculty of Science, Jordan University, Amman, Jordan
Paul Rademacher* and Heinz Bandmann
Institut für Organische Chemie, Universität GH Essen, W-4300 Essen 1, Germany

Abstract - 6-Monosubstituted 5,6-dihydro-4H-1,2,4,5-oxatriazines (**3**) undergo ring contraction, *via* elimination of H_2O, to yield the respective 1H-1,2,4-triazoles (**4**). This transformation is envisaged to proceed *via* the ring-opened (E)-hydrazonoxime (**5**) which then suffers dehydrative cyclization. The process is acid-catalyzed and is thermally induced. Apparently, the driving force for this transformation is linked to the aromaticity of the triazole product.

Recently, we have reported[2] on the synthesis of 5,6-dihydro-4H-1,2,4,5-oxatriazines (**3**) *via* direct interaction between methylhydrazones (**2**) and nitrile oxides, generated *in situ* from the appropriate arylhydroxamoyl chloride precursors (**1**) by the action of triethylamine. The chemistry of these heterocycles remains, however, unexplored. The present work aims at investigating the thermal stability of model dihydro-oxatriazines (**3**). For this purpose we have prepared an additional set of these heterocycles following the above-mentioned route (Scheme 1).

Scheme 1



2 - 4	a	b	c	d	e/f	g	h/i
R	Me	Et	iPr	Cyclohexyl	4-MeC_6H_4	4-$MeOC_6H_4$	2-$MeOC_6H_4$

j/k	l	m	n	o	p/q	r	s
2-HOC_6H_4	4-$NO_2C_6H_4$	3-$NO_2C_6H_4$	C_6H_5	3-Py	2-Py	2-Furyl	2-Thienyl

Analytical and spectroscopic data for compounds (**3**) are consistent with the assigned dihydro-oxatriazine ring system (Tables 1, 2, and 3). Thus, the ir spectra exhibit a sharp N-H stretching band in the range 3280 - 3300 cm^{-1} and an absorption at 1580 - 1610 cm^{-1} attributed to C^3=N stretching. The ^1H nmr spectra show the exchangeable N^5-H as a doublet at about 3.9 - 4.0 ppm (**3a-d**) and 4.2 - 5.0 ppm (**3e-s**) due to vicinal coupling with the C^6-H ($J \approx 11$ Hz). The C^6-H in compounds (**3e-s**) appears as a doublet (at about 5.2 - 5.5 ppm) that collapses to a singlet upon addition of D_2O. In compounds (**3a-d**) this C^6-H proton signal (4.0 - 4.3 ppm) shows splitting patterns expected from additional coupling with the vicinal proton(s) in R (at C^6). Upon addition of D_2O, the pattern is reduced to a quartet (**3a**: 4.3 ppm), a triplet (**3b**: 4.2 ppm), and a doublet (**3c**, **3d**: 4.2 ppm). The singlet of the N^4-CH_3 protons is observed in the range 2.6 - 2.9 ppm.

The proton-decoupled ^{13}C nmr spectra of **3** exhibit, besides other expected signals, two characteristic signals in the range 82 - 86 and 155 - 158 ppm ascribed, respectively, to the C^6 and C^3 oxatriazine ring carbons. The former signal shows up as a doublet in the off-resonance spectra in accord with the 5,6-dihydro-4H-1,2,4,5-oxatriazine structure.[2] The N^4-CH_3 carbon resonates at about 43 - 44 ppm. The mass spectra of compounds (**3**) display peaks corresponding to the correct molecular ion as well as fragment ions in agreement with the ring-cracking pattern previously noted[2] for the dihydro-oxatriazine system.

When heated above its melting point as solid (**3a,b,g**) or in boiling xylene (**3e,3g**), each member of these dihydro-oxatriazines underwent ring contraction, with elimination of H_2O, to yield the respective 1-methyl-1H-1,2,4-triazoles (**4a,b,e,g**). The reaction took the same course when the appropriate oxatriazine (**3**) was refluxed in acetic acid for 20 - 30 min. In this case, the yields of the resulting triazoles (**4**) (crude products) are, in several instances, almost quantitative. The structures of the products (**4**) were assigned on the basis of analytical (Table 1) and spectroscopic data (Tables 4 and 5).

The mass spectra of **4** display prominent parent peaks (base peaks in several cases) that correspond to the correct molecular ions suggested by the molecular formulae. The ir spectra exhibit C=N bond stretching at ca. 1590 - 1610 cm^{-1}. The ^1H nmr spectra of **4** show the signal of the N-CH_3 protons at about 4.0 - 4.2 ppm indicating them to be deshielded compared to their signal position in the dihydro-oxatriazine precursors (**3**). This downfield shift is the result of the triazole ring current effect, absent in the parent dihydro-oxatriazines.

The ^{13}C nmr spectra of **4** exhibit two signals in the lowest field region at ca. 153 - 162 ppm assigned to the C^3 and C^5 sp^2-hybridized carbons of the

Table 1. Physical and Analytical Data of Compounds (**3**)[a] and (**4**)[a].

No.	X	Yield[b] (%)	mp (°C)	Mol. Formula	[M]$^+$ (m/z)	requires/found (%) C	H	N
3a	*p*-Br	65	180-181	$C_{10}H_{12}N_3OBr$	269/	44.46	4.48	15.56
					271	44.50	4.54	15.65
3b	*m*-NO_2	54	108-109	$C_{11}H_{14}N_4O_3$	250	52.79	5.64	22.39
						53.00	5.79	22.33
3c	*p*-Br	67	110-111	$C_{12}H_{16}N_3OBr$	297/	48.34	5.41	14.09
					299	48.45	5.47	14.05
3d	*p*-Br	60	141-142	$C_{15}H_{20}N_3OBr$	337/	53.26	5.96	12.42
					339	53.38	6.00	12.48
3e	*p*-Br	70	155-156	$C_{16}H_{16}N_3OBr$	345/	55.51	4.66	12.14
					347	55.52	4.78	12.14
3f	*m*-NO_2	50	145-146	$C_{16}H_{16}N_4O_3$	312	61.53	5.16	17.94
						61.33	5.18	17.92
3h	H	48	138-139	$C_{16}H_{17}N_3O_2$	283	67.83	6.05	14.83
						67.98	6.14	15.03
3l	H	58	155-156	$C_{15}H_{14}N_4O_3$	298	60.39	4.73	18.78
						60.43	4.14	18.94
3m	H	55	68-69	$C_{15}H_{14}N_4O_3$	298	60.39	4.73	18.78
						60.41	4.35	18.66
3n	H	50	132-133	$C_{15}H_{15}N_3O$	253	71.13	5.97	16.59
						71.27	5.98	16.80
3o	H	52	135-136	$C_{14}H_{14}N_4O$	254	66.13	5.55	22.03
						65.91	5.58	21.83
3p	H	52	115-116	$C_{14}H_{14}N_4O$	254	66.13	5.55	22.03
						65.89	5.65	22.32
3q	*p*-Cl	60	176-177	$C_{14}H_{13}N_4OCl$	288/	58.24	4.54	19.40
					290	58.37	4.28	19.44

No.	X	Yield[b] (%)	mp (°C)	Mol. Formula	[M]+ (m/z)	requires/found (%) C	H	N
3r	*p*-Cl	58	149-150	$C_{13}H_{12}N_3O_2Cl$	277/	56.23	4.36	15.13
					279	55.99	4.29	15.42
3s	*m*-Br	62	137-138	$C_{13}H_{12}N_3OBrS$	337/	46.17	3.58	12.42
					339	45.84	3.43	12.60
4a	*p*-Br	74	71-72	$C_{10}H_{10}N_3Br$	251/	47.64	4.00	16.67
					253	47.72	4.08	16.75
4b	*m*-NO_2	80	77-78	$C_{11}H_{12}N_4O_2$	232	56.89	5.21	24.12
						56.78	5.34	24.10
4c	*p*-Br	72	68-69	$C_{12}H_{14}N_3Br$	279/	51.45	5.04	15.00
					281	51.17	4.94	15.13
4d	*p*-Br	83	72-73	$C_{15}H_{18}N_3Br$	319/	56.26	5.67	13.12
					321	56.22	5.92	13.23
4e	*p*-Br	85	134-135	$C_{16}H_{14}N_3Br$	327/	58.55	4.30	12.80
					329	58.68	4.36	12.99
4f	*m*-NO_2	80	147-148	$C_{16}H_{14}N_4O_2$	294	65.30	4.79	19.04
						65.35	5.00	18.90
4g	*p*-Cl	82	143-144	$C_{16}H_{14}N_3OCl$	299/	64.11	4.71	14.02
					301	64.36	4.91	14.24
4i	*m*-NO_2	82	149-150	$C_{16}H_{14}N_4O_3$	310	61.93	4.55	18.05
						61.68	4.76	17.82
4k	*p*-Cl	78	148-149	$C_{15}H_{12}N_3OCl$	285/	63.05	4.23	14.71
					287	63.04	4.16	14.80
4p	H	74	138-139	$C_{14}H_{12}N_4$	236	71.17	5.12	23.71
						71.36	5.17	23.62
4q	*p*-Cl	82	136-137	$C_{14}H_{11}N_4Cl$	270/	62.11	4.10	20.70
					272	61.95	4.30	20.57

No.	X	Yield[b] (%)	mp (°C)	Mol. Formula	[M]⁺ (m/z)	requires/found (%) C	H	N
4r	*p*-Cl	80	109-110	$C_{13}H_{10}N_3OCl$	259/	60.13	3.88	16.18
					261	60.30	4.00	16.23
4s	*m*-Br	85	107-108	$C_{13}H_{10}N_3BrS$	319/	48.76	3.15	13.12
					321	48.71	3.14	12.90

[a]) Compounds **3g** (X = *p*-Cl), **3i** (X = *m*-NO_2), **3j** (X = H), **3k** (X = *p*-Cl),[2] and **4h,j,l-o** (X = H)[3] have been described previously.

[b]) Yields refer to crystallized products; those of **4a-s** are based on heating **3a-s** in AcOH, procedure (i).

triazole ring. The N-CH_3 carbon resonates at about 36 - 38 ppm and is thus shielded compared to its position in the dihydro-oxatriazines (**3**). As would be expected from this "dihydro-oxatriazine ⟶ triazole" ring transformation, the ^{13}C nmr spectra of **4** lack the signal at 80 - 90 ppm belonging to the sp^3-C^6-ring carbon present in the dihydro-oxatriazines.[2] Also, the N-H stretching and the exchangeable N-H signal, observed for compounds (**3**), are absent in the respective ir and ^1H nmr spectra of the corresponding conversion products (**4**). The ir and nmr spectral results are in agreement with reported data[3] for known 1-methyl-1H-1,2,4-triazoles.

As was noted previously,[2] the formation of **3** implies the intermediacy of the transient open-chain adduct (Z)-**5**, initially formed as the kinetically controlled adduct; the latter then intracyclizes spontaneously to **3** in an allowed "6-Endo-Trig" process.[4]

Table 2. ^{1}H Nmr Chemical Shifts (δ values) of Compounds (3).

Compd.	4-CH_3 (s)	5-H(d)	6-H[a]	aromatic[b]	6-R
3a	2.73	3.95	4.38(dq, J= 6 and 11 Hz)	7.35-7.51	CH_3 1.38(d,J=6 Hz)
3b	2.80	4.00	4.20(dt, J= 6 and 11 Hz)	7.30-8.40	$-CH_2CH_3$ 1.75(2H,dq, J=6 and 7.5 Hz) 1.13(3H,t,J=7.5 Hz)
3c	2.74	3.90	4.00(dd, J= 6 and 11 Hz)	7.38-7.55	$-CH(CH_3)_2$ 1.94(1H,m) 1.07(6H,2d,J=7 Hz)
3d	2.73	3.90	4.00(dd, J= 6 and 11 Hz)	7.38-7.54	$-CH(CH_2)_4CH_2$ 1.22-1.92(11H,m)
3e	2.85	4.19	5.22(d)	7.12-7.56	*p*-CH_3 2.33(3H,s)
3f	2.84	4.20	5.22(d)	7.17-8.40	*p*-CH_3 2.33(3H,s)
3h	2.87	4.70	5.50(d)	6.92-7.60	*p*-OCH_3 3.87(3H,s)
3l	2.89	4.40	5.42(d)	7.26-7.63	
3m	2.90	4.42	5.41(d)	7.40-8.46	
3n	2.89	4.28	5.30(d)	7.39-7.62	
3o	2.88	4.40	5.40(d)	7.32-8.63	
3p	2.89	5.00	5.32(d)	7.10-8.70	
3q	2.89	4.90	5.30(d)	7.24-8.66	
3r	2.90	4.40	5.41(d)	7.40-8.10	
3s	2.68	5.00	5.31(d)	7.30-8.42	

[a] Compounds (**3e** - **s**) J_{CH-NH} = 11 Hz.

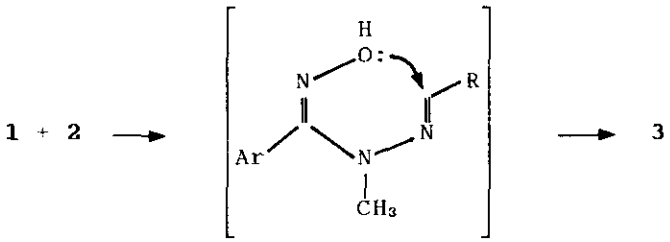
[b] Represent the aromatic species at 3- and 6-positions.

Table 3. ^{13}C Nmr Chemical Shifts (δ values) of Compounds (**3**).

Compd.	C-3	C-6	H_3C-N^4	aromatic[a]	6-R
3a	155.91	79.77	43.58	124.38-	$-CH_3$
				131.77	17.31
3b	155.17	84.36	43.57	123.00-	$-CH_2CH_3$
				148.46	24.76
					8.73
3c	156.16	86.38	43.47	124.40-	$-CH(CH_3)_2$
				132.00	30.05
					17.42
					17.51
3d	158.18	86.38	43.49	124.38-	$-CH(CH_2)_5$
				132.04	39.58
					25.78-
					27.82
3e	156.09	83.47	43.79	123.91-	*p*-CH_3
				139.36	21.26
3f	155.08	83.65	43.79	123.19	*p*-CH_3
				150.32	21.31
3h	157.17	81.16	43.58	110.99-	*p*-OCH_3
				156.74	55.74
3l	157.40	82.52	43.80	121.30-	
				137.75	
3m	157.42	82.53	43.80	121.20-	
				137.58	
3n	157.06	83.59	43.82	126.60-	
				135.62	
3o	157.28	83.88	43.82	123.42-	
				150.35	

Compd.	C-3	C-6	H_3C-N^4	aromatic[a]
3p	157.02	83.45	43.84	119.42-154.04
3q	156.94	83.26	43.84	119.34-154.37
3r	157.40	83.53	43.80	121.21-148.45
3s	157.10	83.50	43.84	120.40-154.04

[a]) Represent the aromatic species at 3- and 6-positions.



(Z)-**5**

The present results demonstrate that 4-methyl-5,6-dihydro-4H-1,2,4,5-oxatriazines (**3**) are potential precursors for the preparation of 1-methyl-1H-1,2,4-triazoles (**4**). Mechanistically, the ring transformation **3** ⟶ **4** is assumed to proceed *via* ring opening of **3** to give initially the transient acyclic tautomer (Z)-**5** which is prone to isomerize, under the reaction conditions, to the thermodynamically controlled intermediate (E)-**5**. The latter acyclic isomer is the actual species undergoing dehydrative cyclization to give **4** as depicted in Scheme 2. The overall process is acid-catalyzed and is thermally induced.

Table 4. ^{1}H Nmr Chemical Shifts (δ values) of Compounds (**4**).

Compd.	1-CH_3 (s)	aromatic[a]	3-R
4a	3.96	7.66-8.51	-CH_3
			2.40(3H,s)
4b	4.03	7.60-8.60	-CH_2CH_3
			2.89(2H,q,J=7.5Hz)
			1.35(3H,t,J=7.5Hz)
4c	4.12	7.41-7.92	-$CH(CH_3)_2$
			3.32(1H,sep,J=7 Hz)
			1.52(6H,d,J=7 Hz)
4d	4.06	7.30-7.72	-$CH(CH_2)_5$
4e	4.00	7.24-8.00	*p*-CH_3
			2.40(3H,s)
4f	4.14	7.24-8.63	*p*-CH_3
			2.40(3H,s)
4g	4.02	6.77-7.56	*p*-OCH_3
			3.58(3H,s)
4i	4.13	7.03-8.64	*o*-OCH_3
			3.96(3H,s)
4k	4.15	6.90-8.08	*o*-OH
			10.90(1H,s)
4p	4.03	7.33-8.53	
4q	4.06	7.54-8.61	
4r	4.08	6.43-7.72	
4s	4.07	7.15-7.92	

[a] Represent the aromatic species at 3- and 5-positions.

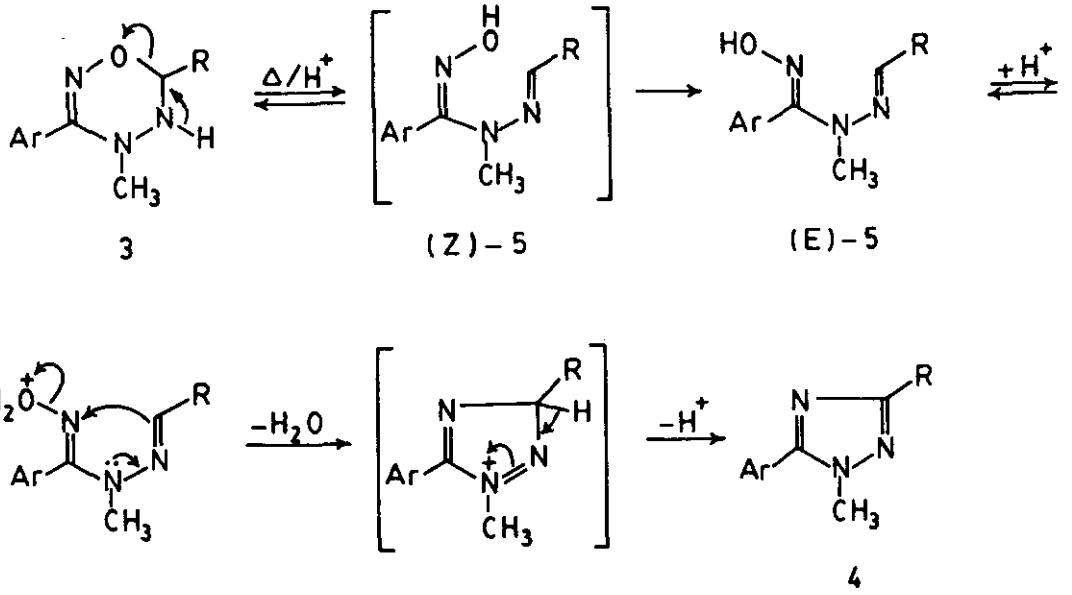
Table 5. ^{13}C Nmr Chemical Shifts (δ values) of Compounds (**4**).

Compd.	C-3	C-5	H_3C-N^1	aromatic[a]	3-R
4a	160.26	152.55	36.84	123.26- 148.28	$-CH_3$ 13.70
4b	165.11	152.45	36.78	123.32- 148.23	$-CH_2CH_3$ 21.58 12.58
4c	168.82	152.36	36.74	123.43- 148.36	$-CH(CH_3)_2$ 28.21 21.60
4d	158.80	154.53	37.32	124.20- 132.42	$-CH(CH_2)_5$ 39.82 25.88- 26.45
4e	161.25	154.36	36.90	124.49- 139.11	*p*-CH_3 21.34
4f	161.70	153.13	37.24	123.56- 148.49	*p*-CH_3 21.42
4g	158.76	155.16	37.39	127.84- 136.98	*p*-OCH_3 55.31
4i	160.11	157.53	37.31	120.80 152.64	*o*-OCH_3 56.09
4k	160.19	157.98	37.88	117.73- 152.00	
4p	160.64	155.84	37.26	121.48- 149.91	
4q	160.45	154.85	37.35	121.54- 149.70	

Compd.	C-3	C-5	H_3C-N^1	aromatic[a]
4r	154.51	154.48	37.13	109.21-146.18
4s	157.49	153.98	36.97	122.92-133.47

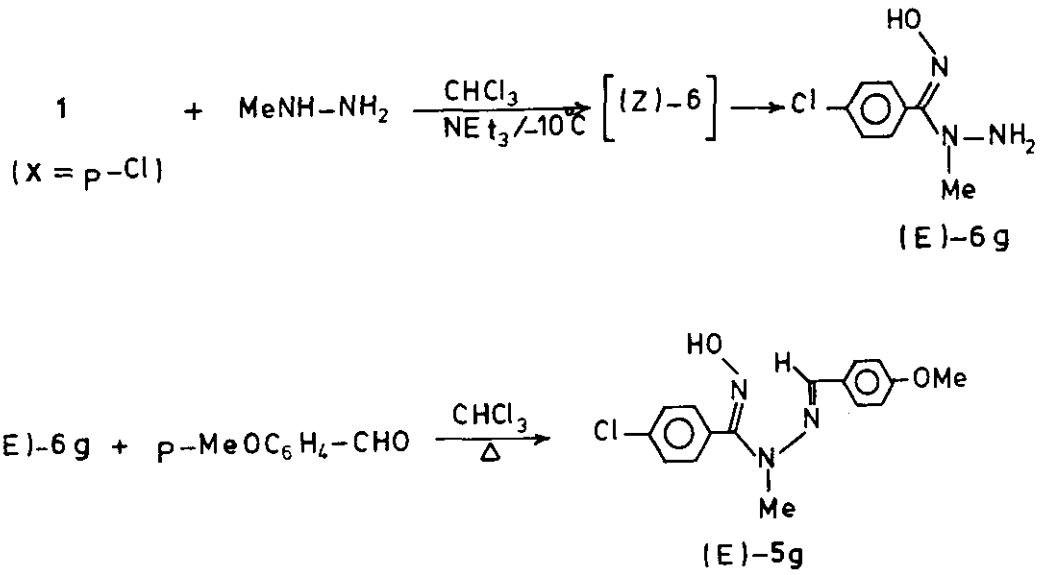
[a]) Represent the aromatic species at 3- and 5-positions.

Scheme 2



Evidence in support of this pathway comes from the following observation: The acyclic hydrazonoxime ((E)-**5g**) is prepared from the hydrazidoxime ((E)-**6g**) by reaction with *p*-anisaldehyde (Scheme 3). Since this starting hydrazidoxime, as prepared, is assumed to exist predominantly in the (E)-form,[2] the resulting hydrazonoxime (**5g**) would also be in the (E)-form. The absence, in the spectrum for **5g**, of a ^{13}C nmr signal at 80-90 ppm (which is characteristic for the sp^3-C^6 in cyclic **3g**) indicates the acyclic nature of the hydrazonoxime (**5g**). A less stable (Z)-form for **5g** is excluded here since it is expected to cyclize immediately to the sole tautomer (**3g**).

Scheme 3



In a separate run, (E)-**5g** underwent cyclization to the triazole **4g** in refluxing acetic acid, a condition that also converts **3g** into **4g** (Scheme 3).

It is worth mentioning that Risitano and coworkers[3] have obtained the triazoles (**4n,o**) directly from the appropriate monomethylhydrazone (**2**) and (**1**) in refluxing ether for 2 h. The authors also isolated the acyclic adducts (**5h,j,l**) [corresponding to (E)-**5g**], which were converted, in a subsequent step, into the respective triazoles (**4h,j,l**) upon treatment with ethanolic HCl under reflux.[3] In the present work, the same triazoles (**4h,j,l-o**) are accessible from the respective 5,6-dihydro-4H-1,2,4,5-oxatriazines (**3h,j,l-o**) which we isolated and characterized under low-temperature reaction conditions involving **1** and **2**. Consequently, it is reasonable to assume that here 4-methyl-5,6-dihydro-4H-1,2,4,5-oxatriazines (**3**) are first formed, which then suffer dehydration (*via* **5**) to **4** under Risi-

tano reaction conditions. Collectively, the above results lend support to the mechanistic steps

3 ⟶ [(Z)-5] ⟶ (E)-5 ⟶ **4**

as postulated in Scheme 2.

EXPERIMENTAL

Melting points were determined on an electrothermal Mel-Temp apparatus and are uncorrected. Ir spectra were recorded as KBr pellets on a Perkin Elmer 577 spectrophotometer. ^{1}H and ^{13}C nmr spectra were recorded on a Varian XL200 or a Bruker AMX300 instrument for solutions in $CDCl_3$ (unless otherwise stated) at 21°C. EI mass spectra were run on a Finnigan MAT731 spectrometer at 70 eV. Elemental microanalyses were performed at M.H.W. Laboratories, Phoenix, Arizona, U.S.A.

Arylhydroxamoyl chlorides (**1**). These compounds were prepared by chlorination (gaseous chlorine) of the respective aldoximes as previously described.[5]

Monomethylhydrazones (**2a-s**). These compounds were prepared *via* direct interaction between methylhydrazine and the respective aldehyde as cited in the literature: **2a-d**,[6] **2e**,[7] **2g-o**,[8] **2p**,[9] **2r**,[10] and **2s**.[8]

Preparation of 5,6-dihydro-4H-1,2,4,5-oxatriazines (**3a-e** and **3l-s**; Table 1). These heterocyclic derivatives were prepared following a procedure similar to that reported for the closely related analogues (**3g,i,j,k**).[2] Thus, a solution of the appropriate arylhydroxamoyl chloride (**1**, 0.01 mol) in chloroform (30 ml) was added, dropwise, to a stirred solution of the respective methylhydrazone (**2**, 0.02 mol) and triethylamine (4.2 ml, 0.03

mol) in chloroform (30 ml) at -10°C. The reaction mixture was then stirred for 1 h at 0°C to -5°C, and then at ambient temperature for 30 min. The resulting solution was washed with water (30 ml), and the organic layer was dried ($MgSO_4$). The solvent was then removed in vacuo at 20°C, and the residue was recrystallized from chloroform/petroleum ether (bp 40 - 60°C).

Preparation of 1H-1,2,4-triazoles (**4a-s**; Table 1).

(i) The respective 5,6-dihydro-4H-1,2,4,5-oxatriazine (**3**, 0.01 mol) was refluxed in glacial acetic acid (10 ml) for 20 - 30 min (compounds **3e-s**), or for 1 h (compounds **3a-d**). The resulting solution was diluted with water (100 ml) and cooled; the precipitated solid product was collected, dried, and recrystallized from chloroform/petroleum ether (bp 40-60°C). In a number of cases, where no heavy precipitation of the product occurs, it was necessary to extract the aqueous layer with chloroform (2x40 ml). The combined chloroform extracts were washed with water, dried ($MgSO_4$), the solvent was removed, and the residue was recrystallized as above.

(ii) Compound **3g** (3.2 g, 0.01 mol), contained in an open vessel, was immersed in an oil bath preheated to 155-160°C for 5-10 min. During this period a cloud of water vapor was extruded from the melt. The reaction vessel was then cooled, and the residue was triturated with petroleum ether. The resulting solid was then collected and recrystallized from ethanol. Yield: 2.4 g (80 %). mp 143 - 144°C, undepressed upon admixture with a sample of **4g**, prepared *via* procedure (i) above. Triazoles (**4a,b**) were likewise obtained in yields of 70 % and 75 %, respectively, by thermal heating of the precursors (**3a,b**) at temperatures 5 - 10°C above their melting points.

(iii) Compound **3g** (3.2 g, 0.01 mol) in acetic anhydride (15 ml, 0.16 mol) was refluxed for 30-40 min. Water (100 ml) was then added to the resulting

solution, and the precipitated solid product was collected and recrystallized from ethanol. Yield of **4g**: 2.24 g (75 %). mp 143 - 144°C, undepressed upon admixture with a sample of **4g**, prepared *via* procedure (i) above.

(iv) Compound **3f** (3.1 g, 0.01 mol) in xylene (15 ml) was refluxed for 50 - 60 min. The solvent was then removed in vacuo, and the residual solid product was collected and recrystallized from ethanol. Yield of **4g**: 1.7 g (57 %). mp 143 - 144°C, undepressed upon admixture with a sample of **4f** prepared *via* procedure (i) above. Compound (**4e**) was likewise converted into the respective triazole (**3e**) which was recrystallized from chloroform/petroleum ether (bp 40 - 60°C). Yield: 60 %.

(v) Compound **3g** (3.2 g, 0.01 mol) in concentrated hydrochloric acid (15 ml) was refluxed for 1 h. The resulting solution was then diluted with water (100 ml), and the precipitated solid product was collected and recrystallized from ethanol. Yield of **4g**: 1.2 g (40 %). mp 143 - 144°C, undepressed upon admixture with a sample of **4g**, prepared *via* procedure (i) above.

(vi) Compound **3g** (3.2 g, 0.01 mol) in concentrated sulfuric acid (15 ml, 98 %) was stirred at room temperature for 2 h. The resulting homogeneous solution was cautiously poured into crushed ice (100 g), and the precipitated solid product was collected and recrystallized from ethanol. Yield of **4g**: 1.34 g (45 %). mp 143 - 144°C, undepressed upon admixture with a sample of **4g**, prepared *via* procedure (i) above.

Preparation of *p*-chlorobenzohydrazidoxime ((E)-**6**). A solution of *p*-chlorobenzohydroxamoyl chloride (**1** : X = Cl; 3.8 g, 0.02 mol) in chloroform (30 ml) was added, dropwise, to a stirred solution of methylhydrazine (1.3 ml, 0.024 mol) and triethylamine (5.6 ml, 0.04 mol) in chloroform (40 ml) at − 10°C. The reaction mixture was then stirred at 0°C for 30 min, and then at

ambient temperature for 30 min. The solvent was then removed in vacuo, and the semi-solid residue was extracted with ether (4 x 20 ml). Ether was then evaporated and the resulting solid product was recrystallized from chloroform/petroleum ether, and then from ether/petroleum ether. Yield: 2.3 g (58 %). mp 99 - 100°C (lit.,[2] mp 98 - 100°C).

Preparation of N^2-(4-methoxybenzylidene)-N^1-(*p*-chlorobenzohydroxamoyl)-N^1-methylhydrazine ((E)-**5g**). A solution of **6** (2.0 g, 0.01 mol) and *p*-anisaldehyde (1.2 ml, 0.01 mol) in ether (70 ml), containing few drops of glacial acetic acid, was heated for 5 - 6 h. At this time, the reaction was completed as monitored by tlc (silica gel and $CHCl_3$ as the eluent). The solvent was then evaporated from the reaction mixture, and the residue was extracted with ether (4 x 20 ml). The combined ether extracts were dried ($MgSO_4$), and the solvent was then evaporated. The resulting residue was then triturated with ethanol (2 x 5 ml), and the insoluble solid was collected and recrystallized from ether/petroleum ether. Yield: 2.6 g (82 %). mp 153 - 154°C.

Anal. Calcd for $C_{16}H_{16}N_3O_2Cl$: C, 60.48; H, 5.08; N, 13.22. Found: C, 60.26; H, 5.24; N, 13.22.

Evaporation of the ethanol triturant (10 ml) gave the cyclic isomer (**3g**) in poor yield (5 %).

Transformation of **5g** into 1-Methyl-5-(*p*-chlorophenyl)-3-(*p*-methoxyphenyl)-1H-1,2,4-triazole (**4g**). Compound (E)-**5g** (3.2 g, 0.01 mol) in glacial acetic acid (10 ml) was refluxed for 30 min. The resulting solution was then diluted with water (100 ml) and cooled. The precipitated solid product was collected, dried, and recrystallized from chloroform/petroleum ether. Yield: 2.5 g (83 %). mp 143 - 144°C, undepressed upon admixture with a

sample of **4g**, prepared from **3g** *via* a procedure similar to that described in (i) above. Both preparations show identical ir, ^{1}H nmr, and ms spectra.

REFERENCES

1. Part 1: M. M. El-Abadelah, M. Z. Nazer, A. Q. Hussein, A. M. Awadallah, P. Rademacher, and M. Woydt, *J. Heterocycl. Chem.*, 1991, 28, 1299.
2. A.Q. Hussein, M.M. El-Abadelah, H.A. Hodali, M.R. Kamal, and M.M. Aouf, *Heterocycles*, 1987, 26, 2199.
3. F. Risitano, G. Grassi, and F. Foti, *J. Chem. Res.* (S), 1981, 65; *J. Chem. Res.* (M), 1981, 0831-0837.
4. J.E. Baldwin, *J. Chem. Soc., Chem. Commun.*, 1976, 734.
5. A.Q. Hussein, M.M. El-Abadelah, and W.S. Sabri, *J. Heterocycl. Chem.*, 1983, 20, 301; and references therein.
6. G.J. Karabatsos and R.A. Taller, *Tetrahedron*, 1968, 24, 3557.
7. W. Sucrow, L. Zuehlke, M. Slopianka, and J. Pickardt, *Chem. Ber.*, 1977, 110, 2818.
8. R.H. Wiley and G. Irick, *J. Org. Chem.*, 1959, 24, 1925.
9. M.M. El-Abadelah, A.Q. Hussein, and H.A. Saadeh, *Heterocycles*, 1991, 32, 1063.
10. D. Todd, *J. Am. Chem. Soc.*, 1949, 71, 1353.

Received, 11th May, 1992