Synthesis and Mass Spectra of some 1-Aroylamino-5-arylaminomethyl-1,2,3-triazoles

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The title compounds **2** are prepared from the reaction of 1-(*N,N*-diaroyl)amino-5-bromomethyl-1,2,3-triazoles with aromatic amines. The fragmentation pattern upon electron impact at 70 eV of compounds **2** is studied. The molecular ion peak is present in all the spectra examined. Besides the $[M-28]^{+\cdot}$, there is also a more abundant $[M-29]^{+}$ peak, corresponding to a N_2H loss of the molecular ion. The ion $Ar^2NH=CH_2$ is the base or the most prominent peak.

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Derivatives of 1-aminosubstituted-1,2,3-triazole are prepared by oxidation of bis-hydrazones or substituted bis-hydrazones of α-dicarbonyl compounds [1]. They can be used as intermediates for the preparation of interesting fused heterocyclic systems, and recently 1-(*N,N*-diaroyl)amino-5-bromomethyl-1,2,3-triazoles and 1-aroylamino-1,2,3-triazole-1-carboxylic acids were used for the preparation of [1,2,3]triazolo[1,5-*d*][1,3,4]oxadiazine derivatives [2,3]. Also, 1-benzylideneamino- and 1-phenacylideneamino-1,2,3-triazoles reacted with nitrilimine [4], to 1,2,3- and 1,3,4 triazole derivatives, whereas with ketenes *N*-triazolylazetidinones were synthesized [5]. On the other hand, the title compounds have been used for the synthesis of condensed [1,2,3]triazolo[5,1-*f*][1,2,4]triazines [6].

It is therefore of interest to study their spectroscopic characteristics, and especially their mass fragmentation pattern, since in the reported mass spectra of various 1-amino-1,2,3-triazole derivatives [7-10] attention has been mainly paid on the differentiation of their fragmentation pattern caused by the *N*-substituents of the 1-amino moiety, whereas the impact on their fragmentation that might be caused by various 4- or 5-substituents of the triazole ring only in a few cases has been considered [9]. The scope of this work is to study the electron impact mass spectra of the title compounds and to examine the influence, caused by the 5-arylaminomethyl group, in their fragmentation pattern.

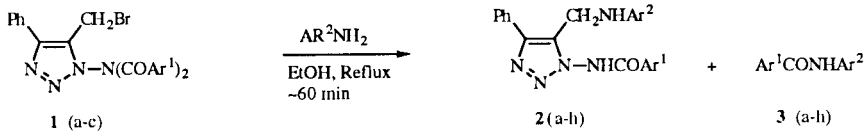
Results and Discussion.

1-Aroylamino-5-arylaminomethyl-1,2,3-triazoles, **2**, have been prepared in good yields from 1-(*N,N*-diaroyl)amino-5-bromomethyl-1,2,3-triazoles [2], **1**, by refluxing with the appropriate aromatic amine.

In their ir spectra compounds **2** show a band at 1680-1690 cm^{-1} for the C=O bond and bands at 3150-3350 cm^{-1} for the NH groups. In their ^1H nmr spectra, the methylenic protons CH_2 appear at δ = 4.1-4.6 as a broadened singlet or, in the case of the compounds **2e** and **2f**, as a doublet with a J = 5.5 Hz and J = 4.2 Hz respectively, from the coupling with the NH proton. The amide proton, NHCO, appears at $\delta \sim 12$ ppm and the Ar^1NH proton shows a broad peak in the region between 4.0 and 6.5 ppm.

The EI mass spectra of compounds **2** show a complicated fragmentation pattern with peaks corresponding to ions resulting from the fragmentation of the triazole ring and of the 5-arylaminomethyl moiety.

All the compounds under study exhibit a prominent peak for the molecular ion $M^{+\cdot}$, which mostly is accom-



1 (a-c)

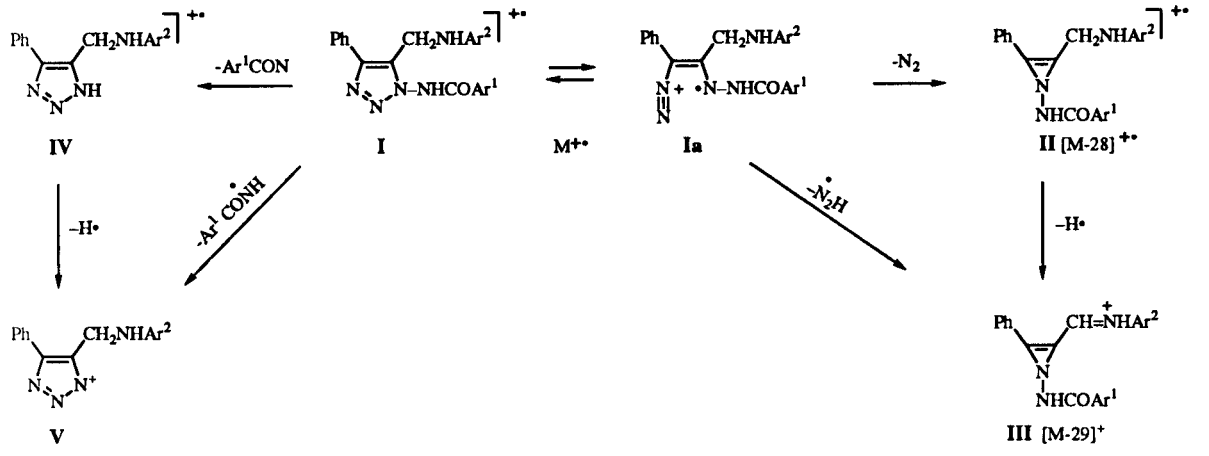
a) $Ar^1 = C_6H_5$
b) $Ar^1 = p$-MeO-C_6H_4
c) $Ar^1 = p$-Cl-C_6H_4

2 (a-h) (55-77%)

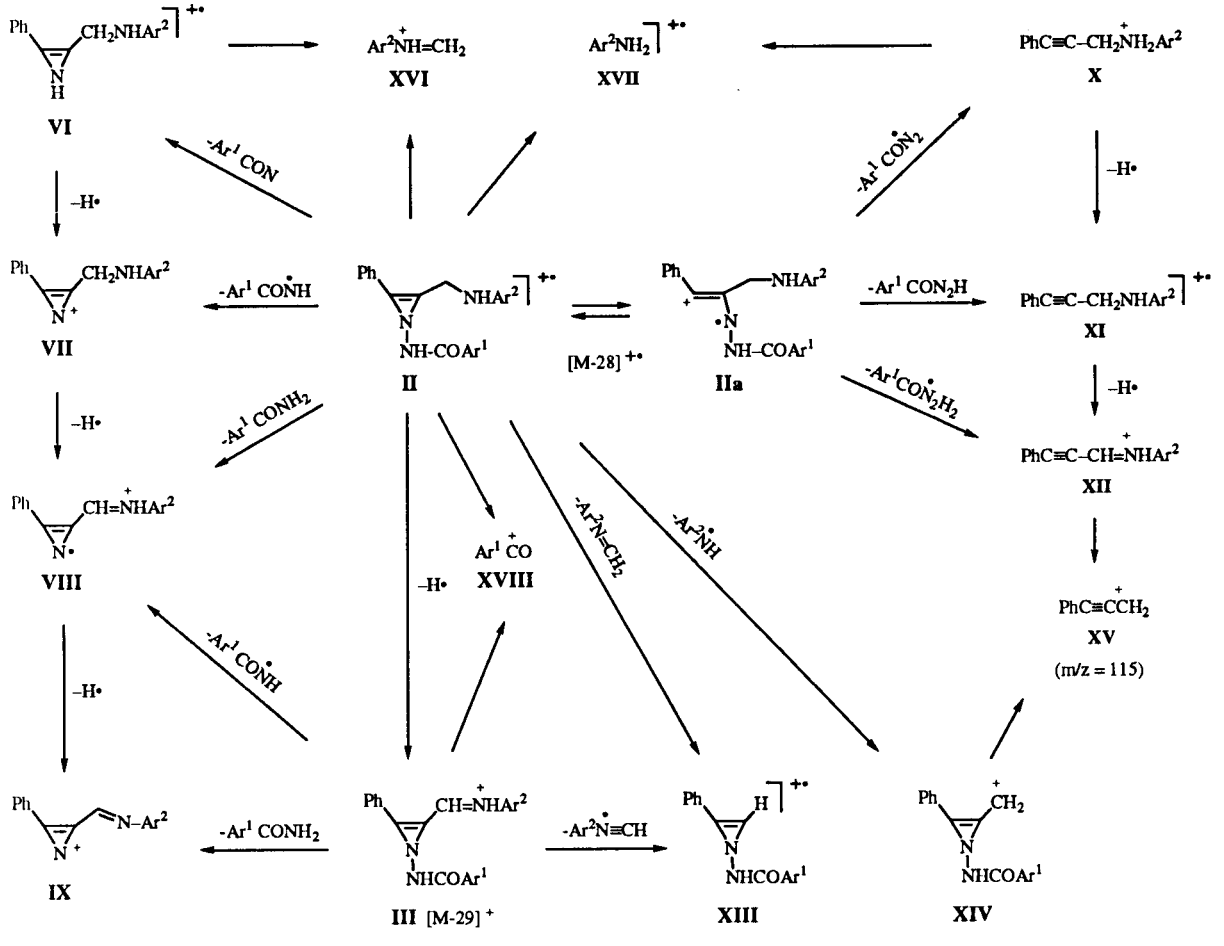
3 (a-h)

a) $Ar^1 = Ar^2 = C_6H_5$
b) $Ar^1 = C_6H_5$, $Ar^2 = p$-MeO-C_6H_4
c) $Ar^1 = C_6H_5$, $Ar^2 = p$-Me-C_6H_4
d) $Ar^1 = C_6H_5$, $Ar^2 = p$-Cl-C_6H_4
e) $Ar^1 = C_6H_5$, $Ar^2 = o$-Cl-C_6H_4
f) $Ar^1 = C_6H_5$, $Ar^2 = p$-O_2N-C_6H_4
g) $Ar^1 = p$-MeO-C_6H_4, $Ar^2 = C_6H_5$
h) $Ar^1 = p$-Cl-C_6H_4, $Ar^2 = C_6H_5$

Scheme 1



Scheme 2



panied by a $[M+1]^+$ peak of comparable relative intensity.

The molecular ion is split either by a loss of N_2 giving rise to the $[M-28]^{+\cdot}$ fragment (Scheme 1), which is typical for the fragmentation of 1-substituted 1,2,3-triazole derivatives [7-11], or by a N_1–NHCO bond cleavage, giving peaks corresponding to the $[M-Ar^1CON]^{+\cdot}$, **IV**, or to the $[M-Ar^1CONH]^+$, **V**, ions (Scheme 1). Analogous fragmentation with N_1–NH splitting has been observed in the mass spectra of 1-sulfonylamino-1,2,3-triazoles [10], whereas 1-aroylamino-5-methyl-1,2,3-triazole derivatives [12] and 1-ureido-5-methyl-1,2,3-triazole derivatives [8] show in their mass spectra the $[M-Ar^1CON]^{+\cdot}$ peak but with very

Table 1

Main Fragment Ions in the EI Mass Spectra of Compounds **2**, m/z, (% Relative Intensities)

	2a	**2b**	**2c**	**2d**	**2e**	**2f**	**2g**	**2h**
$[M+1]^+$	370 (10)	400 (26)	384 (34)	404/406 (8)	404/406 (35)	–	400 (0.2)	404/406 (3)
$[M]^{+\bullet}$	369 (13)	399 (46)	383 (26)	403/405 (14)	403/405 (11)	414 (0.5)	399 (2)	403/405 (7)
$[M-28]^{+\bullet}$	341 (2)	371 (3)	355 (2)	375/377 (3)	375/377 (10)	–	371 (1)	375/377 (1.7)
$[M-29]^+$	340 (10)	370 (4)	354 (5)	374/376 (4)	374/376 (12)	–	370 (1)	374/376 (3)
$[M-Ar^1CON]^{+\bullet}$ (IV)	250 (9)	280 (5)	264 (3)	284/286 (4)	284/286 (6)	295 (1)	250 (4)	250 (3)
$[M-Ar^1CONH]^+$ (V)	249 (33)	279 (10)	263 (11)	283/285 (10)	283/285 (18)	294 (0.8)	249 (23)	249 (8)
$[M-28-Ar^1CON]^{+\bullet}$ (VI)	250 (9)	250 (9)	250 (3)	250 (2)	250 (7)	–	280 (0.5)	284/286 (1)
$[M-28-Ar^1CONH]^+$ (VII)	221 (11)	251 (16)	235 (13)	255/257 (14)	255/257 (20)	266 (1)	221 (5)	221 (5)
$[M-28-Ar^1CONH_2]^{+\bullet}$ (VIII)	220 (7)	250 (9)	234 (7)	254/256 (4)	254/256 (6)	265 (2)	220 (3)	220 (2)
$[M-29-Ar^1CONH_2]^+$ (IX)	219 (23)	249 (26)	233 (16)	253/255 (15)	253/255 (21)	264 (9)	219 (14)	219 (8)
$PhC{\equiv}CCH_2\overset{+}{N}H_2Ar^2$ (X)	208 (14)	238 (21)	222 (30)	242/244 (9)	242/244 (15)	253 (1)	208 (5)	208 (8)
$[PhC{\equiv}CCH_2NHAr^2]^{+\bullet}$ (XI)	207 (5)	237 (12)	221 (7)	241/243 (3)	241/243 (5)	252 (5)	207 (1)	207 (4)
$PhC{\equiv}CCH{=}\overset{+}{N}HAr^2$ (XII)	206 (9)	236 (35)	220 (17)	240/242 (5)	240/242 (7)	251 (1)	206 (5)	206 (6)
$[M-28-Ar^2N{=}CH_2]^{+\bullet}$ (XIII)	236 (45)	236 (35)	236 (24)	236 (60)	236 (55)	236 (20)	266 (32)	270/272 (16)
$[M-28-Ar^2NH]^+$ (XIV)	249 (33)	249 (26)	249 (13)	249 (12)	249 (30)	249	279 (3)	283/285 (6)
$M-29-Ar^1CONH_2-CN]^{+\bullet}$ (XIX)	193 (7)	223 (2)	207 (2)	227/229 (1)	227/229 (1)	–	193 (1)	193 (2)
$PhC{\equiv}\overset{+}{N}Ar^2$ (XX)	180 (11)	210 (10)	194 (11)	214/216 (6)	214/216 (12)	–	180 (1)	180 (5)
$PhC{\equiv}\overset{+}{C}CH_2$ (XV)	115 (64)	115 (40)	115 (76)	115 (88)	115 (80)	115 (39)	115 (26)	115 (50)
$Ar^2\overset{+}{N}H{=}CH_2$ (XVI)	106 (100)	136 (100)	120 (100)	140/142 (52)	140/142 (60)	151 (4)	106 (47)	106 (100)
$[Ar^2NH_2]^{+\bullet}$	93 (18)	123 (45)	107 (15)	127/129 (9)	127/129 (24)	138 (22)	93 (7)	93 (13)
$[Ar^2N{=}CH_2]^{+\bullet}$	105 (80)	135 (8)	119 (3)	139/141 (3)	139/141 (3)	150 (2)	105 (2)	105 (5)
$Ar^1\overset{+}{C}O$	105 (80)	105 (62)	105 (88)	105 (100)	105 (100)	105 (100)	135 (100)	139/141 (32)
$[Ar^1CONH_2]^{+\bullet}$	121 (2)	121 (15)	121 (11)	121 (2)	121 (3)	121 (10)	151 (1)	155/157 (1)
$Ar^1\overset{+}{C}{=}NH$	104 (21)	104 (15)	104 (9)	104 (21)	104 (26)	104 (12)	134 (4)	138/140 (2)
$Ar^2\overset{+}{C}{=}NH$	104 (21)	134 (6)	118 (6)	138/140 (5)	138/140 (7)	149 –	104 (3)	104 (10)
$[Ar^2]^+$	77 (67)	108 (16)	91 (27)	111/113 (9)	111/113 (5)	122 (6)	77 (23)	77 (21)
$Ph\overset{+}{C}{=}NH$ (m/z 104)	(21)	(15)	(9)	(21)	(26)	(12)	(3)	(10)
$[PhCN]^{+\bullet}$ (m/z 103)	(9)	(8)	(4)	(9)	(12)	(9)	(6)	(3)
m/z 77	(67)	(43)	(70)	(50)	(57)	(48)	(23)	(21)

Table 2
Analytical and Spectral Data of Compounds **2**

Compound	Mp (°C)	Yield (%)	IR ν, cm^{-1}	^{1}H NMR, $CDCl_3$/DMSO-d_6 (4:1) (δ, from TMS)	Formula M.W.	Analysis Calcd./Found C	H	N
2a	172-174 (benzene)	71	3360, 3340, 1680	4.20 (s, 2H, CH_2), 4.53 (bs, 1H, NH), 6.40-6.85 (m, 3H), 6.90-7.70 (m, 10H), 7.81-8.12 (m, 2H), 11.75 (bs, 1H, NH)	$C_{22}H_{19}N_5O$ 369.421	71.53 71.62	5.18 5.23	18.96 19.07
2b	147-149 (CH_2Cl_2-*n*-hexane)	55	3340, 3140-3180, 1680	3.66 (s, 3H, OCH_3), 4.12 (s, 3H, CH_2 and NH), 6.50 (d, J = 9 Hz, 2H), 6.65 (d, J = 9 Hz, 2H), 7.15-7.65 (m, 8H), 7.83-8.03 (m, 2H)	$C_{23}H_{21}N_5O_2$ 399.456	69.16 69.23	5.30 5.42	17.53 17.48
2c	162-164 (benzene)	27	3260, 3150, 1680	2.15 (s, 3H, CH_3), 4.15 (s, 2H, CH_2), 6.48 (d, J = 8.5 Hz, 2H), 6.85 (d, J = 8.5 Hz, 2H), 7.15-7.60 (m, 8H), 7.82-8.00 (m, 2H)	$C_{23}H_{21}N_5O$ 383.456	72.04 71.89	5.52 5.31	18.26 18.01
2d	178-180 (benzene)	77	3340, 3140, 1685	4.14 (bs, 1H, NH), 4.38 (s, 2H, CH_2), 6.60 (d, J = 10 Hz, 2H), 7.03 (d, J = 10 Hz, 2H),7.35-7.80 (m, 8H), 7.95-8.15 (m, 2H), 12.50 (bs, 1H, NH)	$C_{22}H_{18}N_5OCl$ 403.874	65.43 65.64	4.49 4.65	17.34 17.58
2e	166-168 (CH_2Cl_2-*n*-hexane)	57	3405, 3180, 1690	4.45 (d, J = 5.5 Hz, 2H, CH_2), 4.89 (t, J = 5.5 Hz, 1H, NH), 6.62 (m, 2H), 7.10 (m, 2H),7.33-7.60 (m, 6H), 7.66-7.84 (m, 2H), 7.96-8.12 (m, 2H), 12.55 (bs, 1H, NH)	$C_{22}H_{18}N_5OCl$ 403.874	65.43 65.55	4.49 4.48	17.34 17.40
2f	233-235 (ethanol)	31	3320, 3250, 1680	4.60 (d, J = 4.2 Hz, 2H, CH_2), 6.38 (bm, 1H, NH), 6.62 (d, J = 9 Hz, 2H), 7.40-7.88 (m, 8H), 7.90-8.20 (m, 4H)	$C_{22}H_{18}N_6O_3$ 414.446	63.76 63.75	4.38 4.23	20.28 20.01
2g	159-161 (CH_2Cl_2-*n*-hexane)	29	3380, 3250, 1690	3.70 (s, 3H, OCH_3), 4.20 (s, 2H, CH_2), 6.48-6.92 (m, 2H), 6.94-7.65 (m, 5H), 7.85 (d, J = 8.5 Hz, 2H), 11.6 (bs, 1H, NH)	$C_{23}H_{21}N_5O_2$ 399.456	69.16 69.17	5.30 5.60	17.53 17.40
2h	147-149 (ether-*n*-hexane)	44	3340, 3160, 1685	4.18 (s, 2H, CH_2), 4.45 (bs, 1H, NH), 6.45-6.80 (m, 3H), 7.0-7.6 (m, 6H), 7.82 (d, J = 8.0 Hz, 2H), 12.0 (bs, 1H, NH)	$C_{22}H_{18}N_5OCl$ 403.847	403.1199/405.1170 403.1111/405.1163		

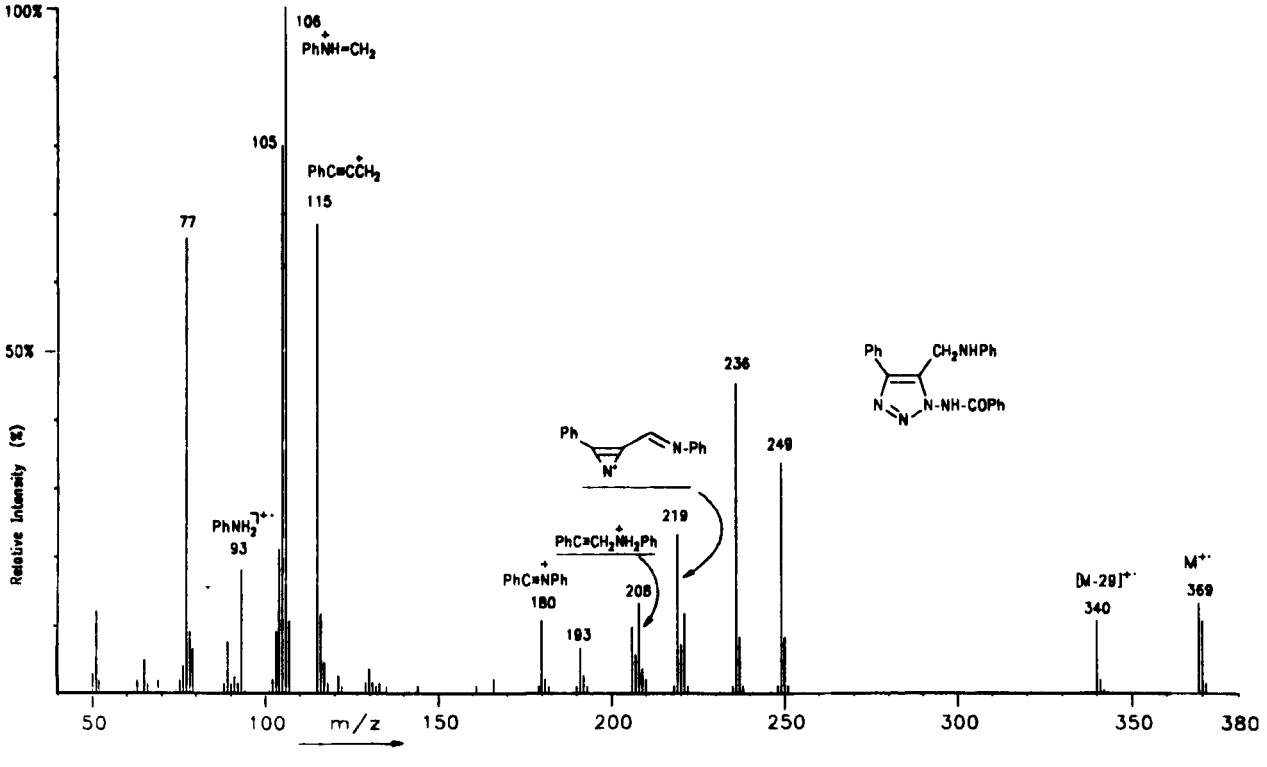
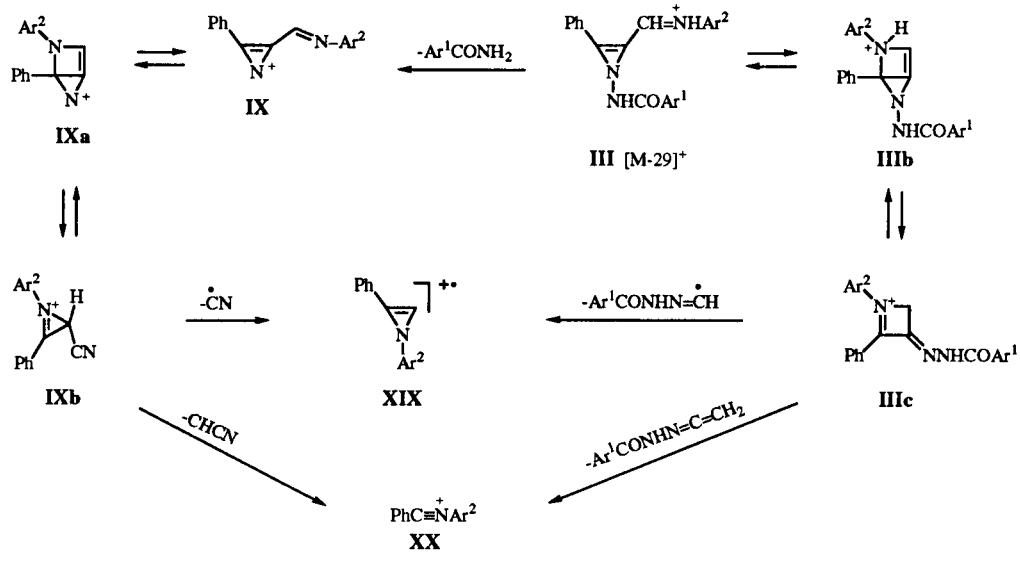


Figure 1. The 70 eV mass spectrum of compound **2a**

Scheme 3



low relative intensity.

Besides the $[M-28]^{+\cdot}$, there is a much more abundant $[M-29]^{+}$ peak, corresponding to a N_2H elimination from the molecular ion. It is noted that the analogous 1-aroylamino-5-methyl-1,2,3-triazoles do not show in their mass spectra the $[M-29]^{+}$ peak [12]. This implies that in the case of compounds **2** it is the 5-arylaminomethyl moiety that provides the hydrogen for the N_2H elimination (Scheme 1).

The $[M-28]^{+\cdot}$ ion, which may adopt either a closed or an open form [9,13], **II** and **IIa** respectively, Scheme 2, by rupture of the N-NH bond, followed by hydrogen shift, gives fragments of moderate abundances corresponding to the $[M-28-Ar^1CON]^{+\cdot}$, **VI**, $[M-28-Ar^1CONH]^{+}$, **VII**, and $[M-28-Ar^1CONH_2]^{+\cdot}$, **VIII**, ions, whereas the $[M-29]^{+}$ ion analogously, besides **VII** and **VIII**, gives the $[M-29-Ar^1CONH_2]^{+}$, **IX**, ion with a moderate relative abundance.

Furthermore the $[M-28]^{+\cdot}$ ion, most probably from its open form, gives the $[M-28-Ar^1CON_2]^{+}$, **X**, $[M-28-Ar^1CON_2H]^{+\cdot}$, **XI**, and $[M-28-Ar^1CON_2H_2]^{+}$, **XII**, ions. Ions **XI** and **XII** could be also formed from the $[M-29]^{+}$ ion in an analogous way.

In another fragmentation path, the $[M-28]^{+}$ ion is split following the fragmentation path of alkylarylamine derivatives, thus giving fragments corresponding to the $[M-28-Ar^2N=CH_2]^{+\cdot}$, **XIII**, and $[M-28-Ar^2NH]^{+}$, **XIV**, ions (Scheme 2).

Of interest are the ions **XIX** and **XX** (Scheme 3), which appear with a low relative intensity. Their elemental composition has been confirmed by accurate mass measurements for compounds **2a** and **2c**. These ions, which require a skeletal rearrangement in order to be formed, could be generated either from the $[M-29]^{+}$, **III**, or from the $[M-29-Ar^1CONH_2]^{+}$, **IX**, fragment, probably through an azetidine intermediate as given in Scheme 3.

The base peak in the mass spectra of compounds **2** corresponds to the $Ar^1\overset{+}{C}O$ or $Ar^2\overset{+}{N}H=CH_2$ ions, whereas there are peaks of prominent abundance at m/z 115, corresponding to the $PhC\equiv C\text{-}\overset{+}{C}H_2$ fragment, which is typical for the 4-phenyl-5-methyl-1,2,3-triazole derivatives, as well as peaks corresponding to the $[Ar^2NH_2]^{+\cdot}$, $Ar^2\overset{+}{N}\equiv CH$, $[Ar^1CONH_2]^{+\cdot}$, $Ar^1C\equiv\overset{+}{N}H$, $[PhCN]^{+\cdot}$, and $PhC\equiv\overset{+}{N}H$ ions. The main fragments appearing in the mass spectra of compounds **2** are given in Table 1. A representative mass spectrum of compound **2a** is given in Figure 1.

EXPERIMENTAL

Melting points were obtained with a Kofler hot stage apparatus and are uncorrected. The ir spectra were recorded as nujol mulls on a Perkin-Elmer 297 spectrometer. The ^1H nmr spectra, reported in δ units, were obtained with a Brucker AW 80 spectrometer in deuteriochloroform-hexadeuteriodimethylsulfoxide mixtures (4:1), with tetramethylsilane (TMS) as internal standard. Elemental microanalyses were performed with a Perkin-Elmer 240B CHN analyzer. Column chromatography separation were performed over Merck Kieselgel 60, particle size 0.063-0.200 mm. The mass spectra were obtained with a VG 250 spectrometer, at 70 eV ionization energy and an ion source temperature of 150°. Samples were introduced directly in the ion source. Accurate masses were measured with the same as above instrument and with a resolution of 5000.

1-(*N,N*-Diaroyl)amino-5-bromomethyl-4-phenyl-1,2,3-triazoles **1a-c** were prepared by reacting the corresponding 1-(*N,N*-diaroyl)amino-5-methyl-4-phenyl-1,2,3-triazoles with *N*-bromosuccinimide, according to the literature [2].

1-Aroylamino-5-arylaminomethyl-4-phenyl-1,2,3-triazoles **2a-h** were prepared by the following general procedure.

A mixture of 5-bromomethyl-1,2,3-triazole **1** (1 mmole) and the corresponding aromatic amine (4 mmoles) in ethanol (10 ml) were refluxed under nitrogen for 45 minutes (In the case of the reac-

tion of **1** with 4-nitroaniline, 1-butanol (10 ml) was used as solvent and refluxing continued for 3 hours). The reaction mixture, after evaporation of the solvent, was chromatographed on a silica gel column using a mixture of *n*-hexane-ethyl acetate as eluant, to give compound **2**. From the column the corresponding benzanilide **3** was also isolated.

Analytical and spectral data of compounds **2** are given in Table 2.

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