N-Nitroso-*N*-(*n*-butoxymethyl)arylamines

Giancarlo Verardo, Angelo G. Giumanini,* Fausto Gorassini, and Paolo Strazzolini

Department of Chemical Sciences and Technologies, University of Udine, I-33100 Udine, Italy

(Received June 22, 1994)

The title compounds were promptly obtained in fair to good yields as distillable liquids by admixing 1,3,5-triarylhexahydro-1,3,5-triazines (**1**) with *n*-butyl nitrite (**2**) in anhydrous CH_2Cl_2 and were fully characterized by ^1H and ^{13}C NMR, IR, and MS. The pure products were invariably made up of geometric isomers which did not interconvert rapidly at room temperature. *o*-Substituents could cause difficulties in the free rotations of the aryl substituent about the C–N bond as well of the α-butoxymethyl group. The reaction is believed to occur on the monomeric imines derived from the thermal equilibration of their trimeric and dimeric precursors. Aliphatic hexahydrotriazines were found to be unreactive under the present conditions.

The reaction of aromatic and aliphatic tertiary amines with *n*-butyl nitrite (**2**) have received recent attention.[1] The outcome could be dramatically changed upon seemingly minor changes in the reaction conditions, like the addition of small quantities of H_2O, NH_4Cl, *p*-toluensulphonic acid, which allowed to unveil the great and useful versatility of *n*-butyl nitrite (**2**).

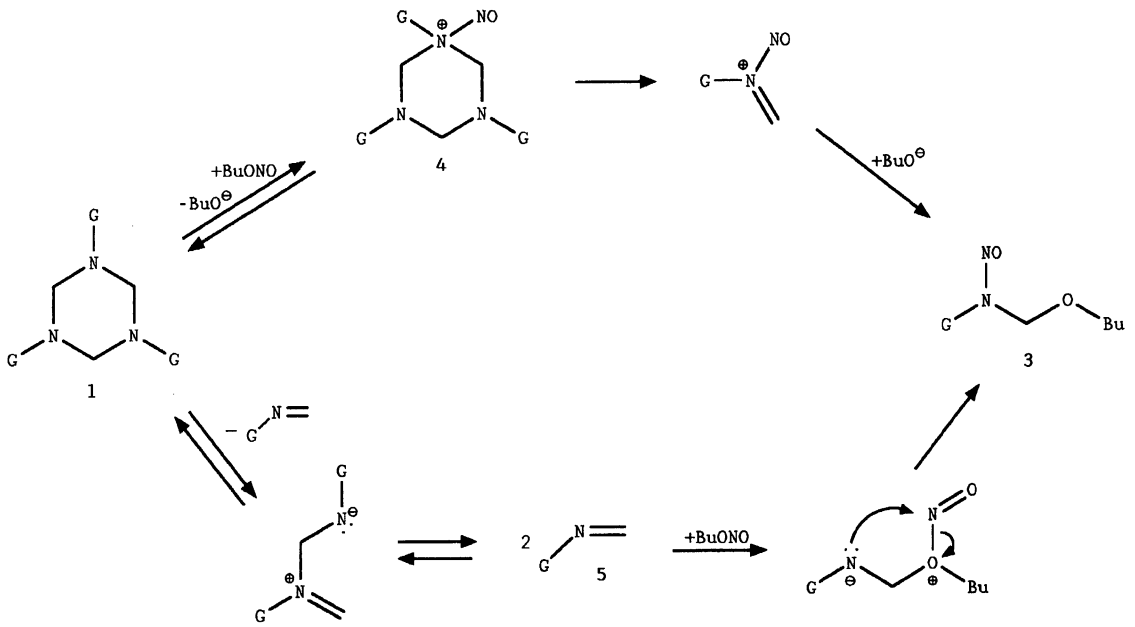
Results and Discussion

Essentially in the framework of the expectations from this knowledge, we wished to observe the type of reactivity expressed by some special cyclic tertiary amines, i.e., 1,3,5-trisubstituted aliphatic and aromatic hexahydro-1,3,5-triazines (**1**) with **2**. The basic 1,3,5-hexahydrotriazine (**1a**), which was expected to favor electrophilic attack by **2**, gave the ready formation of the novel *N*-nitroso-*N*-(*n*-butoxymethyl)arylamines (**3**) in good to excellent yields (Scheme 1). Surprisingly, the more basic aliphatic **1** did not react under the same conditions. Therefore, either **1** is not a reaction intermediate or the reaction does not proceed on **4**, but via the free *N*-methyleneamines **5**, available at equilibrium.[2] In the latter case, the imine **5** is generated by self dissociation of **1**, a process favored for the aromatic 1,3,5-hexahydrotriazines (Scheme 1), but not easily within reach for the aliphatic counterparts at close to room temperatures.

An initial experimentation on **1a** was carried out in order to find favorable reaction conditions, which were identified in the use of concentrated mixtures of **1a** and **2** in the molar ratio 1 : 12 in refluxing anhydrous CH_2Cl_2 during 1 h under inert atmosphere. The excess reagent and solvent were then removed by evaporation and the product obtained by vacuum distillation in fair yield (60–80%). This procedure was applied altogether to eleven different aromatic **1** which yielded the corresponding products **3** (Table 1). The reaction on the cyanoderivative **1k** needed much longer times (20 h) in order to achieve yields comparable to the other substrates. Even longer reaction times and at higher temperatures, did not induce the aliphatic hexahydrotriazines **1l** (R=Me), **1m** (R=Et), **1n** (R=Bz) and **1o** (R=*c*-hex) to react at all with **2**. Failure to observe any transformation

Table 1. *N*-Nitroso-*N*-(*n*-butoxymethyl)arylamines (**3**)

Hexahydrotriazine (*N*-Substituent)	Reaction time h	Product	Yield %
1a (C_6H_5)	1	**3a** (C_6H_5)	68
1b (2-Me-C_6H_4)	1	**3b** (2-Me-C_6H_4)	66
1c (4-Me-C_6H_4)	1	**3c** (4-Me-C_6H_4)	64
1d (4-MeO-C_6H_4)	1	**3d** (4-MeO-C_6H_4)	73
1e (2-F-C_6H_4)	1	**3e** (2-F-C_6H_4)	80
1f (4-F-C_6H_4)	1	**3f** (4-F-C_6H_4)	60
1g (2-Cl-C_6H_4)	2	**3g** (2-Cl-C_6H_4)	70
1h (3-Cl-C_6H_4)	1	**3h** (3-Cl-C_6H_4)	60
1i (4-Cl-C_6H_4)	1	**3i** (4-Cl-C_6H_4)	63
1j (4-Br-C_6H_4)	1	**3j** (4-Br-C_6H_4)	79
1k (4-CN-C_6H_4)	20	**3k** (4-CN-C_6H_4)	70

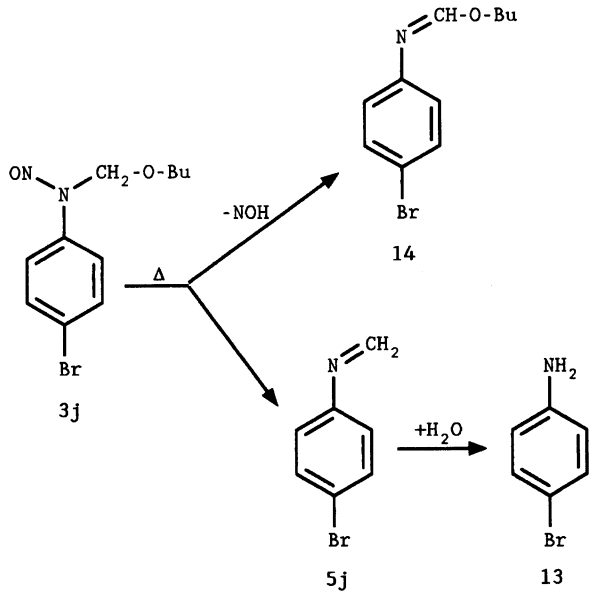


Scheme 1.

to **3** was also met with the free imine *N*-methylene-2,6-diisopropylaniline (**6**) and the C,N-substituted imines *N*-(*n*-butylidene)aniline (**7**), *N*-(*n*-butylidene)cyclohexylamine (**8**), *N*-benzylideneaniline (**9**), *N*-benzylidene-*t*-butylamine (**10**), *N*-(*n*-pentylidene)aniline (**11**) and *N*-benzylidene-*n*-butylamine (**12**). This reactivity pattern allowed to infer a mechanism envisaging the central reversible attack of the *n*-butyl nitrite (**2**) on the hexahydrotriazine, which could only go on when sufficient stabilization of the zwitterionic coproduct could be provided by resonance from attached *N*-aryl groups. In fact, when electron withdrawing substituents, like Cl or CN, are on the 4-position of the phenyl substituents of **1**, the formation of **3** was slowed down appreciably. Additions to the hindered free methylene amino function of **6** are known,[1c] but **2** failed to react with **6** and with the C,N-disubstituted imines. In this framework falls the observation that "aged" **2**, although impossible to be differentiated by IR, NMR, and GC-MS bulk properties, for longer period of heating at higher temperatures, probably slightly decomposing to some acidic product, brought about the reaction on aliphatic **1** yielding aliphatic **4** among other products.

Structural evidence for the nature of products **3** was obtained by IR, ^{1}H and ^{13}C NMR, and mass spectrometry. Although the thermal stability of the aromatic nitroso amino ethers **3** was such that they could be purified by conventional vacuum distillation, they did not usually withstand standard GC conditions. Typically, **3j** gave diffuse peaks corresponding to monomeric **5j**, its unavoidable hydrolysis product 4-bromoaniline (**13**) and a sharp peak for the product of NOH elimination, the imino ether **14** (Scheme 2).

Direct inlet mass spectra of **3a**—**k** (Table 2) exhibited weak parent ions, from which neutral losses of 30u



Scheme 2.

(NO, **15**) and 73u (BuO) were observed as well as the formation of the C_4H_7 ion. Ion **15** easily decomposed to the most intense ion **16** of the spectrum and the ion corresponding to the imine **5a**—**k** (Scheme 3).

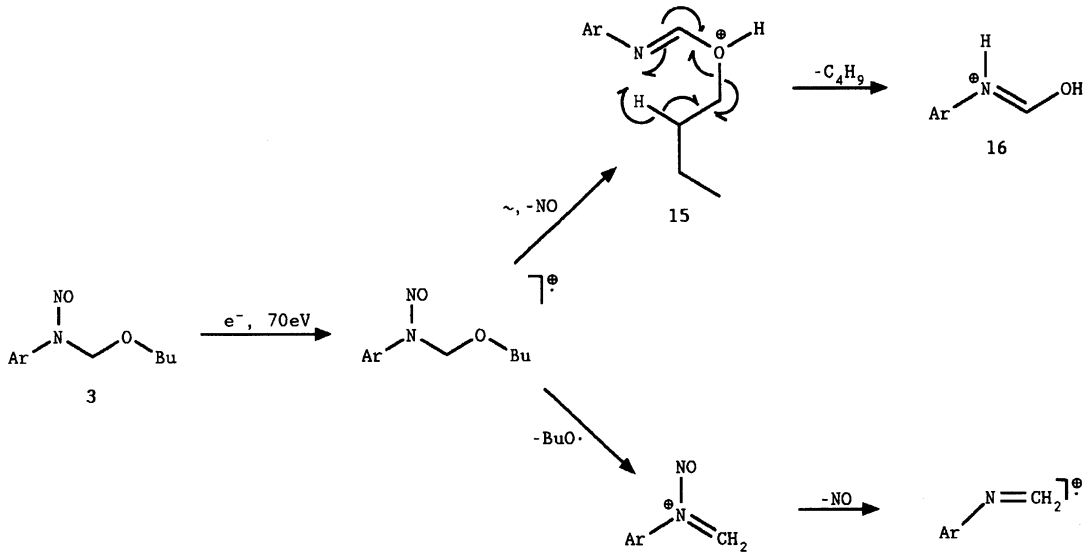
The infrared spectra of the neat liquid **3a**—**k** (Table 2) showed a very strong and broad $\nu_{N=O}$ band located at 1460—1485 cm^{-1} and a ν_{N-N} band of strong intensity in the range 960—1045 cm^{-1}, in agreement with previous observations on aromatic *N*-nitrosamines.[3,1b]

The observed overall picture of ^{1}H NMR spectra of **3** is just that expected: The methyl protons resonated between 0.80 and 1.00 ppm, the β- and γ-methylene hydrogens were gathered between 1.17 and 1.71 ppm, the triplets for the α-methylene protons laid between

Table 2. Properties of *N*-Nitroso-*N*-(*n*-butoxymethyl)arylamines (**3**)

Compd	Bp/P	Anal.	IR	MS
	°C/mbar	Calcd Found	cm^{-1}	*m/z*
3a $C_{11}H_{16}N_2O_2$	115/0.5	C 63.44 63.31 H 7.74 7.75 N 13.45 13.41	2940vs, 2840vs, 1685s, 1595vs, 1480vs, 1440vs, 1380s, 1310vs, 1290s, 1265s, 1165s, 1080vs, 1020vs, 920vs	280 (M^+; 7), 135 (11), 122 (100), 105 (75), 104 (78), 94 (41), 77 (87), 57 (82), 51 (32)
3b $C_{12}H_{18}N_2O_2$	106/0.4	C 64.84 64.72 H 8.16 8.18 N 12.60 12.62	2940vs, 2915vs, 2860s, 1475s, 1330s, 1260s, 1175vs, 1090vs, 1000vs, 740vs	222 (M^+; 1), 192 (64), 149 (22), 136 (100), 118 (80), 107 (52), 93 (49), 91 (73), 77 (29), 65 (54), 57 (68), 51 (24)
3c $C_{12}H_{18}N_2O_2$	110/0.4	C 64.84 64.87 H 8.16 8.17 N 12.60 12.58	2940s, 2900s, 2840s, 2510vs, 1480s, 1165vs, 1085vs, 1050vs, 1015s, 810s	222 (M^+; 5), 192 (44), 136 (100), 120 (38), 119 (56), 118 (60), 108 (47), 106 (41), 91 (78), 77 (30), 65 (46), 57 (53), 51 (23)
3d $C_{12}H_{18}N_2O_3$	95/0.3	C 60.49 60.67 H 7.61 7.63 N 11.76 11.74	2900s, 2840s, 1460vs, 1325s, 1170vs, 1150s, 1075vs, 1040vs, 980s, 735vs	238 (M^+; 2), 237 (9), 208 (67), 152 (100), 135 (76), 124 (60), 120 (74), 108 (56), 92 (53), 77 (28), 65 (46), 57 (53)
3e $C_{11}H_{15}N_2O_2F$	105/0.3	C 58.39 58.28 H 6.68 6.66 N 12.38 12.37	2940s, 2900s, 2840s, 1480vs, 1450s, 1335s, 1270s, 1230s, 1170vs, 1120s, 1080vs, 980s, 770s, 730vs	226 (M^+; 1), 153 (24), 140 (73), 123 (100), 112 (34), 95 (39), 92 (32), 87 (26), 75 (27), 65 (19), 57 (63)
3f $C_{11}H_{15}N_2O_2F$	112/0.3	C 58.39 58.40 H 6.68 6.66 N 12.38 12.39	2920s, 2900s, 1505vs, 1475vs, 1230vs, 1160s, 1080vs, 1045vs, 830s	226 (M^+; 3), 196 (25), 140 (79), 123 (100), 112 (31), 111 (30), 95 (47), 92 (28), 75 (28), 57 (44)
3g $C_{11}H_{15}N_2O_2Cl$	105/0.4	C 54.44 54.34 H 6.23 6.24 N 11.54 11.51	2900s, 2840s, 1460vs, 1325s, 1170vs, 1155s, 1075vs, 1040vs, 980s, 735vs	244 (M^+; 1), 242 (M^+; 2), 169 (18), 156 (71), 139 (52), 138 (49), 128 (27), 111 (47), 93 (51), 87 (35), 75 (38), 57 (100)
3h $C_{11}H_{15}N_2O_2Cl$	120/0.2	C 54.44 54.45 H 6.23 6.22 N 11.54 11.57	2940vs, 2900s, 1595vs, 1570s, 1470vs, 1430s, 1160vs, 1120s, 1080vs, 1050vs, 960s, 920s, 780s, 745s, 680s	244 (M^+; 2), 242 (M^+; 7), 156 (65), 139 (45), 138 (45), 111 (44), 93 (43), 87 (44), 75 (36), 63 (20), 57 (100)
3i $C_{11}H_{15}N_2O_2Cl$	109/0.4	C 54.44 54.48 H 6.23 6.23 N 11.54 11.52	2930vs, 2900vs, 2840s, 1480vs, 1405s, 1380s, 1330s, 1300s, 1275s, 1160vs, 1090vs, 1010vs, 920s, 820vs	244 (M^+; 1), 242 (M^+; 3), 212 (17), 158 (61), 156 (100), 140 (52), 138 (63), 127 (28), 111 (60), 93 (60), 75 (50), 57 (77)
3j $C_{11}H_{15}N_2O_2Br$	113/0.3	C 46.01 46.10 H 5.26 5.27 N 9.75 9.73	2920vs, 2900s, 1480vs, 1160s, 1070vs, 1040vs, 1005s, 920s, 820s	288 (M^+; 2), 286 (M^+; 2), 202 (90), 200 (96), 185 (54), 183 (61), 157 (39), 155 (38), 121 (90), 93 (77), 76 (40), 57 (100)
3k $C_{12}H_{15}N_3O_2$	105/0.4	C 61.79 61.69 H 6.48 6.49 N 18.01 18.06	2910s, 2840s, 2200s, 1605vs, 1485vs, 1340s, 1275s, 1150vs, 1110vs, 1040vs, 910s, 835vs	234 (M^+; 4), 233 (15), 160 (11), 147 (67), 130 (63), 129 (64), 119 (37), 118 (37), 102 (64), 92 (24), 87 (84), 75 (33), 57 (100)

3.30—3.52 and 3.56—3.72 ppm, whereas the singlets for the isolated methylene protons ranged between 5.11 and 5.86 ppm (Table 3). The aromatic patterns were those expected both as to their locations and their look. The observation of two groups of resonances for all the types of protons of the *n*-butyl group revealed that, contrary to what was observed in the case of aromatic *N*-alkyl-*N*-nitrosamines where only the *anti* geometric isomers were present at room temperature,[4] products **3** exhibit both configurations. The overall picture was rationalized as follows. In the case of unsubstituted or *meta* or *para* substituted **3** the predominant *anti* isomer is the one with the phenyl group on the opposite side with respect to the nitroso oxygen, a situation which eliminates the Coulomb repulsion between the ring electrons and the oxygen lone pairs, allowing free rotation about



Scheme 3.

the N–CH_2 bond with the ether oxygen likely to reside preferentially above or below the NNO plane. This more favoured configuration shows the methylene resonance at higher field (Table 3). The *syn* isomer has the merit of allowing a free rotation about the N–CH_2 bond and a plurality of conformations for this side chain.

The situation for the *ortho* derivatives exhibited two features at variance with those described above. The integrals for the two groups of resonances appeared with a reversed ratio for all and with the clearcut dominance of one of the stereoisomers, whereas both the locations of the resonances and their distances were highly invariant (Fig. 1A). We believe that this fact means that the higher field *anti* isomer is now the less represented. The other perspicuous feature is the dramatic broadening of the lower field resonance, which upon warming up the samples to higher temperatures (ca. 60 °C), became a sharp singlet without any change of the *syn*/*anti* ratio of the corresponding isolated methylene peaks. When, on the other hand, the temperature was lowered down to −40 °C the broad peak was resolved into a well defined AB quartet (Fig. 1B). These results can be interpreted as coming from the preferential conformation of the phenyl group showing the *ortho* substituent far away from the *cis* oriented oxygen atom of the NO group. On its own, the *ortho* substituent is pushing the large and electron rich O–Bu group as far away as possible, partially freezing it into such a conformation which will make the individual methylene hydrogens to experiment different environments. The less favoured *anti* isomer has evidently a minor, but not unsignificant, advantage from a *trans* configuration, which sets it far both from the ring π-cloud and the *ortho* substituent. Interestingly, the *o*-F derivative **3e** did not show any peak broadening but only the isomer ratio inversion. Its smaller size possibly favours a conformation with the geminal hydrogens symmetrically riding on itself.

The *syn*/*anti* interchange is definitively very slow for all these derivatives **3** if, as we have observed, the peaks of NCH_2 mantain in the ^{1}H NMR their position, shape and relative ratio upon changing the temperature between −60 and +60 °C. Reinforcing the overall picture offered above to rationalize our observations is the fact that compounds **3** showed a strong prevalence of the *anti* configuration. The electron withdrawing cyano group induces a better conjugation between the ring and the amino nitrogen, thus holding the NNO function and the ring in the same plane, causing a too close vicinity of the *ortho* hydrogen and the oxygen of the NO group.

We have made a preliminary comparative study of the configuration and conformation of the isomeric derivatives **3g**, for which the relevant ^{1}H NMR spectroscopic observations are shown in Figs. 1A and 1B. The value of the rate constant $k_{coal.}$ of interconversion relative to the phenomenon, responsible of the spectral pattern of **3g**, was obtained using the formula:[5]

$$k_{coal.} = \frac{\pi\sqrt{(\nu_A - \nu_B)^2 + 6J_{AB}^2}}{\sqrt{2}}$$

where ν_A, ν_B, J_{AB}, and $k_{coal.}$ are expressed in Hz; the value of the activation energy $\Delta G^{\ddagger}$ comes from the customary formula:[5]

$$\Delta G^{\ddagger} = 19.14 T_{coal.} \left[10.32 + \log \frac{k_{coal.}}{T_{coal.}}\right]$$

where $T_{coal.}$ (K) is actually determined with an uncertainly not higher than 2%. The resulting values where $k_{coal.} = 673$ Hz and $\Delta G^{\ddagger} = 12.9 \pm 0.02$ kcal mol^{-1} respectively. The activation energy for the process is definitively much lower then activation energy for the *syn*/*anti* isomerism of nitrosoamines,[6] an evidence that this is not the process under observation.[7a,b] The sit-

Table 3. ^{1}H NMR and ^{13}C NMR Properties of *N*-Nitroso-*N*-(*n*-butoxymethyl)arylamines (**3**)

Compd	%A[a)]	%B[a)]	^{1}H NMR	^{13}C NMR
3a	68	32	0.85—1.00 (m, 3H, A+B), 1.30—1.65 (m, 4H, A+B), 3.40—3.50 (t, 2H, *J*=6.4 Hz, A), 3.60—3.70 (t, 2H, *J*=6.5 Hz, B), 5.23 (s, 2H, A), 5.80 (s, 2H, B), 7.12—7.70 (m, 5H, A+B)	13.66, 13.96, 19.16, 19.32, 31.49, 31.58, 68.42, 69.61, 69.98, 83.43, 119.41, 125.75, 127.91, 129.00, 129.26, 129.34, 136.96, 141.66
3b	86	14	0.86—0.98 (m, 3H, A+B), 1.33—1.68 (m, 4H, A+B), 2.00 (s, 3H, A), 2.27 (s, 3H, B), 3.46—3.52 (t, 2H, *J*=6.4 Hz, A), 3.62—3.70 (t, 2H, *J*=6.5 Hz, B), 5.11 (s, 2H, A), 5.60—5.90 (broad s, 2H, B), 6.92—7.36 (m, 4H, A+B)	13.66, 17.18, 17.57, 18.94, 19.08, 19.24, 31.27, 31.45, 68.66, 69.93, 70.41, 83.04, 126.40, 126.50, 126.70, 126.88, 129.01, 129.45, 130.55, 130.67, 132.03, 135.80, 136.61, 139.82
3c	40	60	0.82—0.97 (m, 3H, A+B), 1.25—1.69 (m, 4H, A+B), 2.37 (s, 3H, A), 2.40 (s, 3H, B), 3.38—3.46 (t, 2H, *J*=6.4 Hz, A), 3.59—3.67 (t, 2H, *J*=6.5 Hz, B), 5.21 (s, 2H, A), 5.77 (s, 2H, B), 7.00—7.56 (m, 5H, A+B)	13.73, 13.80, 19.11, 19.26, 20.95, 21.21, 31.40, 31.50, 68.36, 69.81, 69.95, 83.49, 119.60, 125.51, 129.89, 129.93, 134.16, 137.29, 139.10, 139.21
3d	49	51	0.83—0.98 (m, 3H, A+B), 1.20—1.70 (m, 4H, A+B), 3.38—3.47 (t, 2H, *J*=6.4 Hz, A), 3.56—3.66 (t, 2H, *J*=6.5 Hz, B), 3.81 (s, 3H, A), 3.85 (s, 3H, B), 5.20 (s, 2H, A), 5.76 (s, 2H, B), 6.74—7.57 (m, 4H, A+B)	13.79, 19.08, 19.24, 31.36, 31.45, 55.38, 55.47, 68.29, 69.93, 70.09, 83.55, 114.43, 114.47, 121.56, 126.10, 127.03, 129.30, 158.93, 159.72
3e	84	16	0.81—0.96 (m, 3H, A+B), 1.17—1.68 (m, 4H, A+B), 3.36—3.44 (t, 2H, *J*=6.5 Hz, A), 3.61—3.69 (t, 2H, *J*=6.4 Hz, B), 5.23 (s, 2H, A), 5.83 (s, 2H, B), 7.06—7.52 (m, 4H, A+B)	13.75, 19.00, 19.17, 31.31, 31.40, 68.50, 70.19, 71.49, 71.57, 82.82, 116.25, 116.65, 117.05, 124.15, 124.44, 124.77, 124.85, 127.20, 127.87, 127.90, 130.27, 130.43, 131.19, 131.35, 154.58, 159.61
3f	41	59	0.82—0.98 (m, 3H, A+B), 1.20—1.71 (m, 4H, A+B), 3.37—3.46 (t, 2H, *J*=6.4 Hz, A), 3.59—3.68 (t, 2H, *J*=6.5 Hz, B), 5.20 (s, 2H, A), 5.78 (s, 2H, B), 7.11—7.68 (m, 4H, A+B)	13.65, 13.73, 19.06, 19.22, 31.34, 31.42, 68.41, 69.82, 69.96, 83.38, 115.93, 116.06, 116.39, 116.51, 121.38, 121.54, 127.65, 127.83, 132.53, 132.60, 137.66, 137.72, 159.29, 159.90, 164.20, 164.86
8g	86	14	0.82—0.97 (m, 3H, A+B), 1.22—1.70 (m, 4H, A+B), 3.40—3.48 (t, 2H, *J*=6.5 Hz, A), 3.64—3.72 (t, 2H, *J*=6.4 Hz, B), 5.20 (s, 2H, A), 5.60—6.05 (broad s, 2H, B), 7.00—7.59 (m, 4H, A+B)	13.74, 19.00, 19.16, 31.30, 31.43, 68.69, 70.40, 71.46, 82.49, 127.65, 127.69, 129.13, 129.18, 130.14, 130.49, 130.55, 130.81, 131.08, 131.74, 134.82, 138.06
8h	27	73	0.83—0.97 (m, 3H, A+B) 1.21—1.70 (m, 4H, A+B), 3.37—3.44 (t, 2H, *J*=6.4 Hz, A), 3.59—3.67 (t, 2H, *J*=6.5 Hz, B), 5.21 (s, 2H, A), 5.79 (s, 2H, B), 7.05—7.72 (m, 4H, A+B)	13.70, 13.77, 19.09, 19.25, 31.35, 31.42, 68.51, 69.36, 69.99, 83.25, 117.08, 119.26, 123.83, 125.89, 127.14, 129.23, 130.22, 130.38, 134.92, 135.18, 137.60, 142.53
8i	33	67	0.83—0.97 (m, 3H, A+B), 1.20—1.66 (m, 4H, A+B), 3.30—3.44 (t, 2H, *J*=6.4 Hz, A), 3.57—3.66 (t, 2H, *J*=6.5 Hz, B), 5.21 (s, 2H, A), 5.78 (s, 2H, B), 7.03—7.65 (m, 4H, A+B)	13.66, 13.74, 19.06, 19.22, 31.33, 31.40, 68.43, 69.40, 69.93, 83.27, 120.36, 126.90, 129.11, 129.43, 132.87, 134.78, 134.99, 14.00
8j	31	69	0.81—0.97 (m, 3H, A+B), 1.20—1.69 (m, 4H, A+B), 3.35—3.43 (t, 2H, *J*=6.4 Hz, A), 3.57—3.66 (t, 2H, *J*=6.5 Hz, B), 5.21 (s, 2H, A), 5.78 (s, 2H, B), 7.02—7.62 (m, 4H, A+B)	13.67, 13.75, 19.06, 19.22, 31.34, 31.40, 68.44, 69.33, 69.94, 83.24, 120.59, 120.69, 122.88, 127.13, 132.41, 132.45, 135.49, 140.48
8k	14	86	0.80—1.00 (m, 3H, A+B), 1.19—1.68 (m, 4H, A+B), 3.35—3.43 (t, 2H, *J*=6.4 Hz, A), 3.60—3.69 (t, 2H, *J*=6.4 Hz, B), 5.25 (s, 2H, A), 5.86 (s, 2H, B), 7.36—7.88 (m, 4H, A+B)	13.64, 19.02, 19.19, 31.29, 68.58, 68.70, 69.94, 83.05, 110.28, 115.62, 118.29, 118.34, 125.73, 133.08, 133.47, 133.83, 139.95, 144.71

a) A is the *anti* isomer and B is the *syn* isomer. Their relative percentage was calculated by ^{1}H NMR.

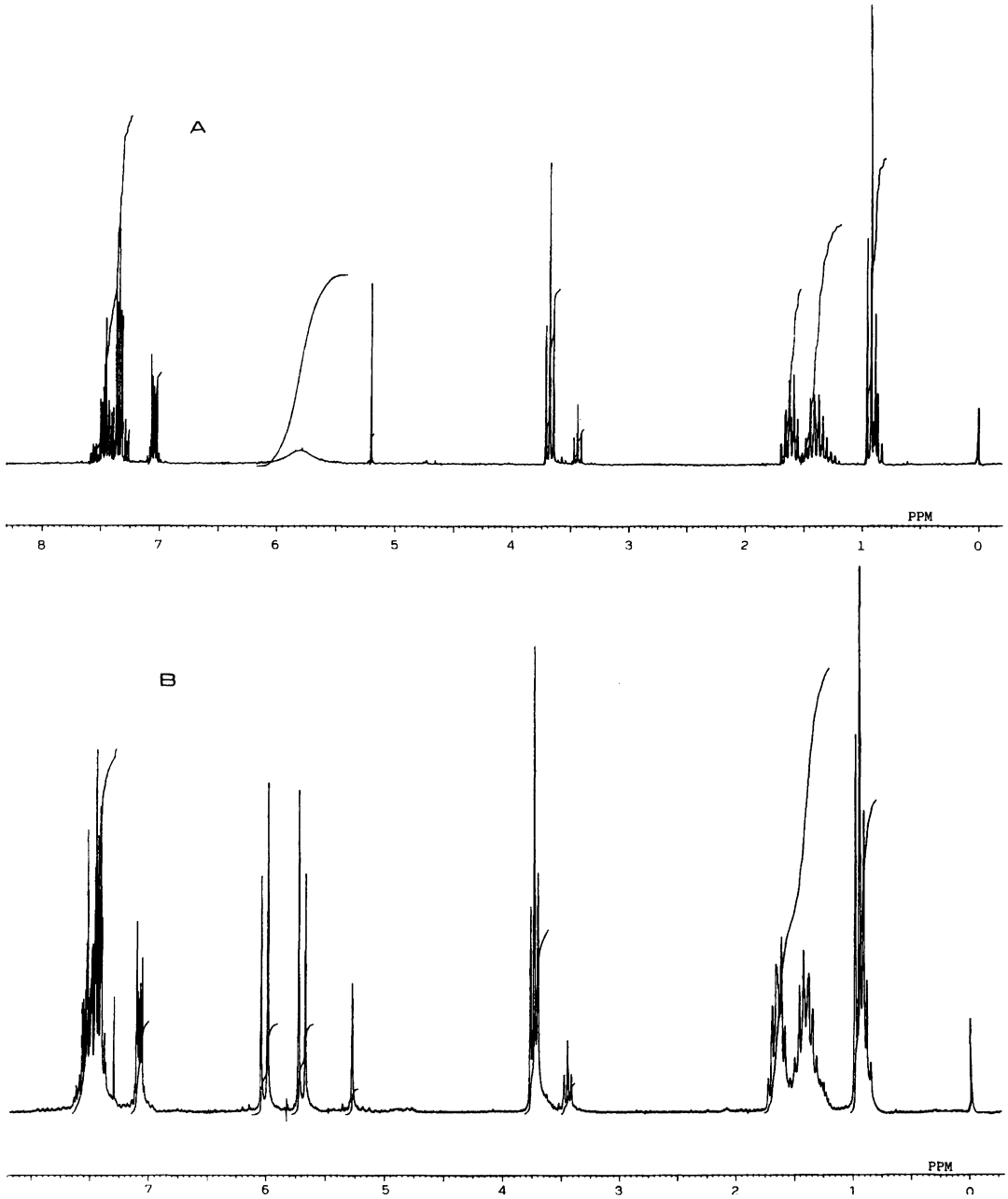


Fig. 1. ^{1}H NMR spectra of *N*-Nitroso-*N*-(*n*-butoxymethyl)-2-chlorophenylamine (**3g**) at 293 K (A) and at 253 K (B).

uation, which we have already described above, may be represented by a lower temperature overall conformation where the *syn* phenyl group is spending most of its time at a significant tortional angle away from coplanarity with the NNO group and the α-methylene group has the hydrogens blocked at opposite sides of the NNO plane (Fig. 2). This conformation is frozen at lower temperatures, whereas above, say, 40 °C all these substituents are set in fast rotations. That the phenyl ring does not lay in the same plane of the NNO function in arylnitrosamines was recently shown in the case of *anti-N*-methyl-*N*-nitrosamines.[8] The origin of the proposed lower temperature conformation may well be the repulsion between the lone pairs electrons of the ether group and the π-electron cloud of the aromatic ring which are compelled to badly rotate away from the NNO plane to avoid the NO/*o*-substituent (or as well *o*-H) steric hindrance.

Experimental

Materials: Primary aromatic amines were commercially available (Aldrich, USA): They were conveniently purified before use and employed to prepare the 1,3,5-trisubstitutedhexahydro-1,3,5-triazines (**1**) according to the amine/paraformaldehyde method.[9] *n*-Butyl nitrite (**2**) was prepared according to a described method.[10] Dry CH_2Cl_2 was obtained following a standard procedure.[11]

Equipment: IR spectra were recorded using a

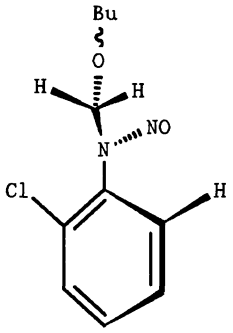


Fig. 2. A view of the conformation of *N*-Nitroso-*N*-(*n*-butoxymethyl)-2-chlorophenylamine (**3g**) giving rise to the ^{1}H NMR pattern of Fig. 1B.

JASCO infrared spectrophotometer Mod. DS-702G. ^{1}H and ^{13}C NMR data were secured from a Bruker Mod. AC-F 200 spectrometer. Electron impact (70 eV) mass spectra were obtained with a Finnigan 1020 mass spectrometer.

Only the most intense peaks beside the parent ion are reported from the mass spectra of new derivatives as well as the most intense IR bands.

Elemental analyses (C, H, and N) were performed with a Carlo Erba Mod. 1106 elemental analizer and were in agreement with calculated values.

General Procedure for the Preparation of 3a—k. A solution of the selected 1,3,5-trisubstituted hexahydro-1,3,5-triazine **1** (10 mmol) and *n*-butyl nitrite (**2**, 120 mmol) in anhydrous CH_2Cl_2 (10 mL) was refluxed in an inert dry atmosphere during 1 h. Solvent and excess **2** were evaporated completely in vacuo and the residue was distilled at ca. 0.1—1.0 mbar. All the prepared **3** are obtained as red-brown viscous oils, whose purity could be checked by direct inlet mass spectrometry, ^{1}H NMR and elemental analysis. Derivative **3g** required 2 h reflux and **3k** 20 h. All the products **3** appeared somewhat thermally unstable, yielding the retrogradation products either slowly on standing at room temperature or when injected at 280 °C in the injection part of a gaschromatograph. Data on individual products are collected in Tables 1, 2, and 3.

The aliphatic triazines 1,3,5-trimethylhexahydro-1,3,5-triazine (**1l**), 1,3,5-triethylhexahydro-1,3,5-triazine (**1m**), 1,3,5-tribenzylhexahydro-1,3,5-triazine (**1n**) and 1,3,5-tricyclohexylhexahydro-1,3,5-triazine (**1o**) did not react under the described conditions and even when they were refluxed with **2** alone during 2 d.

C,N-Substituted imines *N*-(*n*-butylidene)aniline (**7**), *N*-(*n*-butylidene)cyclohexylamine (**8**), *N*-benzylideneaniline (**9**), *N*-benzylidene-*t*-butylamine (**10**), *N*-(*n*-pentylidene)-aniline (**11**) and *N*-benzylidene-*n*-butylamine (**12**) failed in yielding the addition products of **2**.

This work was supported in part by grants to AGG (CNR 92.00391CT03, 93.03024CT03, MURST 1990 and 1992, 60%), to PS (MURST 1991 and 1992, 40% and 60%) and to GV (MURST 1990—1992, 60%). FG is the recipient of a postdoctoral scholarship from the Autonomous Region of Friuli–Venezia Giulia for the year 1994. The authors are grateful to Mr. P. Padovani for expert instrumental maintenance and to Dr. P. Martinuzzi for NMR analysis.

References

1) a) G. Verardo, A. G. Giumanini, and P. Strazzolini, *Tetrahedron*, **46**, 4303 (1990); b) G. Verardo, A. G. Giumanini, and P. Strazzolini, *Tetrahedron*, **47**, 7845 (1991); c) A. G. Giumanini, G. Verardo, F. Gorassini, and P. Strazzolini, in course of publication; d) A. G. Giumanini, M. F. Caboni, and G. C. Galletti, *Gazz. Chim. Ital.*, **111**, 515 (1981); e) J. Casado, F. M. Lorenzo, M. Mosquera, and M. F. R. Prieto, *Can. J. Chem.*, **62**, 136 (1984); f) S. E. Alfred and D. L. H. Williams, *J. Chem. Soc., Perkin Trans. 2*, **1981**, 1021.

2) A. G. Giumanini, A. Bertoluzza, S. Bonora, and G. Fini, *J. Prakt. Chem.*, **332**, 595 (1990).

3) R. L. Williams, R. J. Pale, and G. J. Jeacoke, *Spectrochim. Acta*, **20**, 225 (1964).

4) G. Cerioni, A. G. Giumanini, G. Verardo, and H. Dahn, *Magn. Reson. Chem.*, **32**, 46 (1994).

5) H. Gunther, "NMR Spectroscopy," J. Wiley & Sons, Inc., New York (1980), Chap. VIII.

6) S. Patai, "Supplement F: The Chemistry of Amino, Nitroso, and Nitro Compounds and Their Derivatives," J. Wiley & Sons, Inc., London (1982), Part 1, Chap. 1, pp. 43—46.

7) a) C. E. Looney, W. D. Phillips, and E. L. Reilly, *J. Am. Chem. Soc.*, **79**, 6136 (1956); b) H. S. Gutowsky and C. H. Holm, *J. Chem. Phys.*, **25**, 1228 (1956).

8) W. Caminati and A. G. Giumanini, *J. Mol. Spectrosc.*, **162**, 255 (1987).

9) A. G. Giumanini, G. Verardo, L. Randaccio, N. Bresciani-Pahor, and P. Traldi, *J. Prakt. Chem.*, **327**, 739 (1985).

10) B. S. Furniss, B. S. A. J. Hannaford, P. W. G. Smith, and A. R. Tatchell, "Vogel's Textbook of Pratical Organic Chemistry," 5th ed, J. Wiley & Sons, Inc., New York (1989).

11) D. D. Perrin, W. L. F. Armarego, and D. R. Perrin, "Purification of Laboratory Chemicals," 2nd ed, Pergamon Press, Oxford (1980).