Studies on the Preparation of *N*-Alkyl-*O*-phenylhydroxylamines

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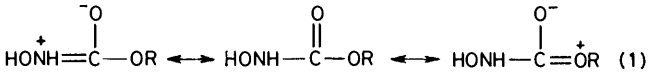
Several possible routes to the title compounds have been investigated. The reaction of *N*-hydroxycarbamates (1) with diphenyliodonium bromide gave, unexpectedly, *N*-hydroxy-*N*-phenylcarbamates (2), while *N*-methyl-*N*-hydroxycarbamates (6) gave 2-(*N*-methyl-*N*-alkoxycarbonylamino)phenols (7). Mechanistic aspects of the *N*-arylations and subsequent rearrangements are discussed. The desired *N*-alkyl-*O*-phenylhydroxylamines were obtained by the reduction of *O*-phenyloximes (15) with sodium cyanoborohydride.

In connection with our current work on sigmatropic rearrangements which involve cleavage of nitrogen–oxygen bonds [1] we required a series of *N*-alkyl-*O*-phenylhydroxylamines. This class of compounds, in spite of the simple structure, has not been reported previously. We expected the preparation to be easy and straightforward. However, we encountered serious complications and made some interesting observations, which we report here.

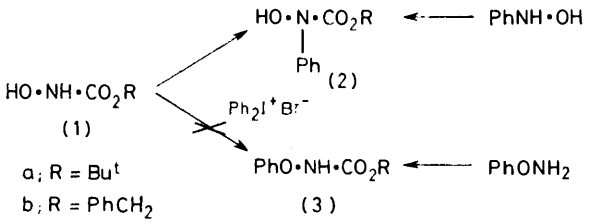
Our initially attempted approach was the *N*-alkylation of *N*-acyl-*O*-phenylhydroxylamines, and subsequent removal of the acyl group. The only known representative of the requisite type of compounds was the *N*-benzoyl derivative (phenyl benzohydroxamate), available by *O*-arylation of benzohydroxamic acid (as potassium [2] or thallium [3] salt) with diphenyliodonium halides. We have tried to prepare the phenoxycarbamates (3a) and (3b) by the same method, since we expected the carbamates to be more suitable for our purpose for two reasons. (i) The tendency of hydroxamate esters to be alkylated on the carbonyl oxygen [4] (explained by formation of a five-membered cyclic ion pair [5]) should be diminished in the carbamates, since the carbonyl would be less nucleophilic [6] as a result of stronger resonance stabilization [equation (1)]. (ii) The carbamate group



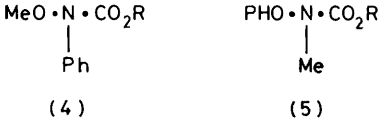
(1)

would be removed easily under mild conditions, and thus decomposition of the sensitive product would be avoided.

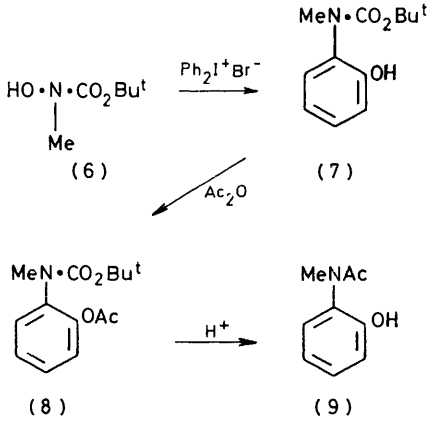
Accordingly we allowed the potassium salt of t-butyl *N*-hydroxycarbamate (1a) to react with diphenyliodonium bromide, to give an arylation product in 50% yield. Surprisingly it was identified as t-butyl *N*-hydroxy-*N*-phenylcarbamate (2a), a compound identical with that obtained by reaction of *N*-phenylhydroxylamine and bis(t-butylcarbonic) anhydride. The compound expected (3a) was prepared independently from *O*-phenylhydroxylamine and bis(t-butylcarbonic) anhydride. Methylation of the product gave t-butyl *N*-methoxy-*N*-phenylcarbamate (4a) (δ CH_3 3.8) isomeric with the desired t-butyl *N*-methyl-*N*-phenoxycarbamate (5a) (δ CH_3 3.2) obtained from (3). Similarly the arylation of benzyl *N*-hydroxycarbamate (1b) gave mainly (2b) with a small amount of (3b) (product ratio 5 : 1). This unexpected *N*-arylation, which is in contrast with the reported *O*-arylation, made it necessary to introduce the *N*-alkyl group prior to the reaction with the iodonium salt. Consequently, the arylation of t-butyl



N-hydroxy-*N*-methylcarbamate (6a) was carried out in the hope that it would furnish (5a). The product (50%) was however not (5a), being identified instead as 2-(*N*-t-butyloxycarbonyl-*N*-methylamino)phenol (7). The i.r.

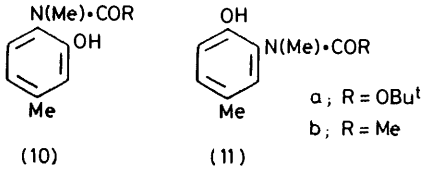


spectrum showed no absorption at 690—700 cm^{-1} (monosubstituted benzene), but possessed a peak at 3 200 cm^{-1} (phenolic OH). Acetylation gave an acetyl derivative (8) with carbonyl absorption at 1 770 cm^{-1}

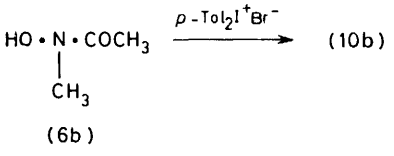


(phenyl ester). Removal of the t-butyloxycarbonyl group from (7) and from (8) gave 2-(methylamino)-phenol and 2-(*N*-methylacetamido)phenol (9) respec-

tively, the latter formed by O→N acyl migration. These were identified by direct comparison with authentic samples prepared according to the literature.[7] Clearly, the arylation of (6) is accompanied by a rearrangement, and in order to clarify its course the reaction sequence was repeated using di-(*p*-tolyl)iodonium bromide. Formation of (10) would indicate *N*-arylation with migration of oxygen, while formation of (11) would indicate *O*-aryl-

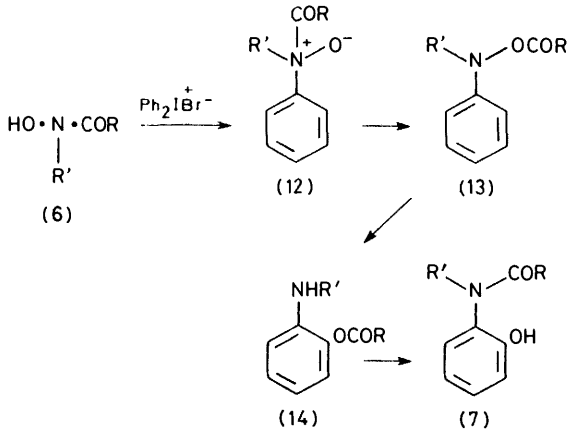


ation with migration of nitrogen. Compound (11b) was synthesized independently, starting with *p*-cresol, and was found to be different from the product. Evidence for structure (10a) was obtained from the high-resolution (270 MHz) n.m.r. spectrum. The ring protons showed, on an expanded scale (0.01 p.p.m./cm), the typical pattern of 1,2,4-tri-substituted benzenes. The doublet of doublets (J_{ortho} = 7.7 Hz, J_{meta} = 1.7 Hz) appeared at the highest field (δ 6.71); close to it was the doublet with the *meta*-splitting (δ 6.79), while the *ortho*-coupled doublet appeared lower (δ 6.96). This spectrum fits no other isomer except (10a). On *O*-acetylation the doublet of doublets (H-5) underwent the largest downfield shift (Δδ 0.31 p.p.m.). The H-3 doublet (*meta*-coupled) was shifted less (Δδ 0.23 p.p.m.) and the H-6 doublet (*ortho*-coupled) showed the smallest change (Δδ 0.15 p.p.m.). The order and magnitude of these shifts are in accord with the structural assignment.[8] Arylation of *N*-methylacetohydroxamic acid gave (10b) directly.

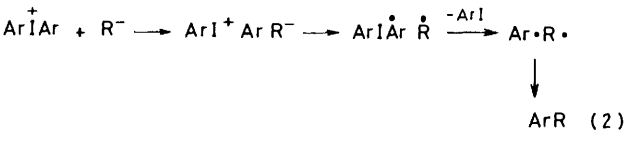


The fact that emerges from these results is that *N*-alkylhydroxamic acids and *N*-alkyl-*N*-hydroxycarbamates are also arylated on the nitrogen. The initially formed intermediate is therefore the amide oxide (12) which probably rearranges to the *O*-acyl-*N*-alkyl-*N*-phenylhydroxylamine (13). The next two steps, which are migration of an acyloxy-group from nitrogen to the *ortho*-carbon (14) and acyl migration from oxygen to nitrogen, have been demonstrated previously.[9]

The nucleophilic site in all previously studied reactions of hydroxamic acids salts with electrophiles [10] is the oxygen, and the present case is certainly an exception which proceeds by a different mechanism. The *N*-arylation of (6) excludes the possible involvement of an ambident anion. It has been suggested [11] that the arylation of carbanions by iodonium salts involves free radicals and proceeds *via* an ion pair, electron transfer to a radical pair, and radical coupling [equation (2)]. This mechanism agrees best with our case where R = ONR'-COR, since the electron transfer would be facilitated by the resonance stabilization of the formed nitroxyl radical [equation (3)]. Although no comprehensive study on

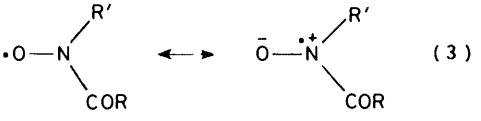


the coupling site of nitroxyl radicals [12] was made, nor was it correlated with the unpaired electron distribution or with the electronic and steric effects of the substituents, evidence has been presented [13] that such couplings occur both on nitrogen and oxygen. Arylation of oxime salts also gave substantial proportions of *N*-arylation.[14] Only



further work on nitroxyl coupling would provide explanation for the differences in behaviour and in products composition in the reaction of various hydroxylamine derivatives with iodonium salts.

Since it had become evident that *O*-arylation of hydroxylamines cannot serve as the key step in the preparation of the desired *N*-alkyl-*O*-phenylhydroxylamines, we turned to *O*-amination of phenol. Potassium phenolate reacts with hydroxylamine-*O*-sulphonic acid to give the unsubstituted *O*-phenylhydroxylamine in low yields.[15] In a similar manner we tried to get the *N*-alkyl



derivatives directly by reacting potassium phenolate with *N*-methyl- and *N*-ethyl-hydroxylamine-*O*-sulphonic acid.[16] No detectable amounts of the desired hydroxylamines were obtained in these reactions.

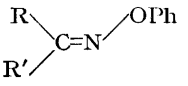
The only alternative left was to use *O*-phenylhydroxylamine, despite its troublesome preparation, as starting material. As described above it served for the preparation of (3a), which was methylated to give (5a). Removal of the t-butyloxycarbonyl group afforded

N-methyl-*O*-phenylhydroxylamine. Introduction of higher alkyl groups onto (3a), however, proceeded only in very low yields, and that made the method impractical.

Finally, the *N*-alkylation of *O*-phenylhydroxylamine was achieved *via* reduction of *O*-phenyloximes (15). The oximes (15) (Table 1) were obtained by treating *O*-phenylhydroxylamine with aldehydes or ketones. They decomposed with time, but were stable enough to allow characterization and analysis. The n.m.r. spectra revealed that the acetaldehyde derivative (15b) was formed as a 1 : 1 mixture of the two stereoisomers, while benzaldehyde gave only the *syn*-isomer, assigned on the basis of the chemical shift of the formerly aldehydic proton.[17] The selective reduction presented a serious problem owing to the high sensitivity of the N–O bond in the oximes (15) towards reductive cleavage. Several reduction methods and reagents, including the recently published use of pyridine–borane,[18] failed. The successful reagent finally employed was sodium cyanoborohydride,[19] by which a series of *O*-phenyloximes were reduced to the corresponding hydroxylamines (16) in moderate yields. Selectivity was achieved only when 1 equivalent of the reagent was used, and even then the formaldehyde derivative (15a) underwent cleavage. The acetophenone derivative (15e) was only partly reduced under those conditions, but the amount of reagent could not be increased. Since the *N*-alkyl-*O*-phenylhydroxylamines (16) were unstable liquids which could not be purified by distillation or chromatography, the structures were verified (n.m.r. or mass-spectrum, Table 2) rapidly, and the crude products were immediately used further. For characterization the hydroxylamines (16) were benzoylated, and the resulting phenyl *N*-alkylbenzohydroxamates (17) are listed in Table 3.

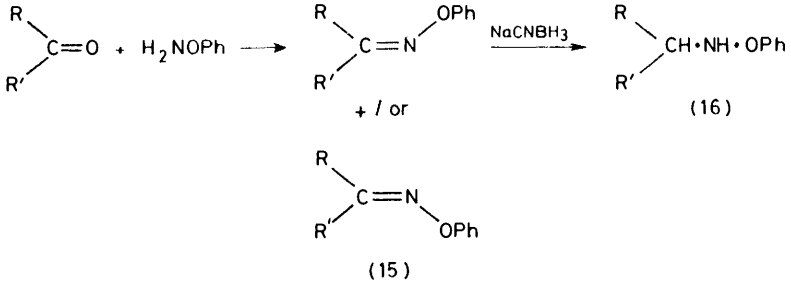
TABLE 1

Physical and analytical data of *O*-phenyloximes



(16)	R	R′	Yield (%)	M.p. (°C)	I.r. ν(C=N)/cm^{-1}	N.m.r.[a] (δ, *J* in Hz)	Formula	Analysis (%) Found C	H	N	Required C	H	N
a	H	H	63	Unstable liquid	1 585	7.37, 6.76 (d, 1 H, each, *J* = 8) 7.76 (1 H, q) 2.00 (3 H, d, *J* = 6)							
b(*syn*)	H	Me	94	Oil	1 580	7.05 (1 H, q), 2.05 (3 H, d, *J* = 6)	C_8H_9NO	70.8	6.5	10.0	71.1	6.7	10.4
b(*anti*)	Me	H											
c	Me	Me	87	Oil	1 585	1.90, 1.95 (s, 3 H each)	$C_9H_{11}NO$	72.1	7.2	9.5	72.5	7.4	9.4
d	$[CH_2]_5$		92	47	1 580	2.67, 2.33 (br, 2 H each), 1.68 (br, 4 H)	$C_{12}H_{15}NO$	76.0	8.1	7.7	76.2	8.0	7.4
e	H	Ph	90	51	1 580	8.38 (1 H, s)	$C_{13}H_{11}NO$	79.4	5.9	6.8	79.2	5.7	7.1
f	Me	Ph[c]	83	Oil	1 580	2.43 (3 H, s)	$C_{14}H_{13}NO$	79.4	6.2	6.5	79.6	6.2	6.6

[a] Aromatic protons not included. [b] A 1 : 1 mixture of stereoisomers. [c] Assumed stereochemistry.



Further studies involving the hydroxylamines (16) will be reported separately.

EXPERIMENTAL

M.p.s were taken with a Thomas Hoover apparatus. I.r. spectra of solids were taken as Nujol mulls and of liquids as films on a Perkin-Elmer 157 spectrometer. N.m.r. spectra were taken in $CDCl_3$ solutions (Me_4Si as internal standard) on Varian T–60 or EM–360 spectrometers or (at 270 MHz) on a Brucker WH–270 spectrometer. Mass spectra (70 eV) were recorded on Varian MAT–311 instrument. Column chromatography was carried out on silica gel 60 (Merck), 70—230 mesh.

Arylation of t-Butyl N-*Hydroxycarbamate* (1a).—The sodium salt of (1a) was prepared by dissolving 1.33 g (0.01 mole) in 10 ml of ethanolic 1M-sodium ethoxide, stirring for 10 min and evaporation. The salt was dissolved in dimethyl sulphoxide (20 ml), diphenyliodonium bromide (3.61 g, 0.01 mol) was added, and the solution was stirred at room temperature overnight. It was then filtered, poured into ice–water, and extracted with ether (3 × 50 ml). The extract was dried ($MgSO_4$) and evaporated, and the dark oily residue

TABLE 2

N-Alkyl-*O*-phenylhydroxylamines, RNHOPh

R	Purity (%)	^{1}H N.m.r. (δ, *J* in Hz)	Mass spectra (*m/e*, relative intensity)
Et	80 [a]	6.9—7.5 (5 H, m), 3.17 (2 H, q), 1.13 (3 H, t, *J* = 7)	
Pr^i	>95	6.8—7.4 (5 H, m), 3.48 (1 H, h), 1.14 (6 H, d, *J* = 6)	151 (M^+, 10%) 94 (100%)
cyclo-C_6H_{11}	90 [a]	6.9—7.4 (5 H, m), 3.02 (1 H, br), 0.9—2.1 (10 H, m)	191 (M^+, 4%) 94 (100%)
$PhCH_2$	80 [a]	7.1—7.8 (5 H, m), 7.28 (5 H, s), 3.82 (2 H, s)	
PhC(Me)H	50 [b]	6.7—7.8 (10 H, m), 4.38 (1 H, q), 1.45 (3 H, d, *J* = 7)	

[a] Contaminated with cleavage products. [b] Contaminated with unchanged oxime.

chromatographed on silica gel. Elution with chloroform–ethyl acetate (9 : 1) and crystallization from light petroleum (b.p. 60—80 °C) yielded *t-butyl*-N-*hydroxy*-N-*phenylcarbamate* (2a) (0.81 g, 39%), m.p. 87 °C, $\nu_{max.}$ 3 210 and 1 695 cm^{-1}; δ 7.99 (1 H, s, exchangeable with D_2O), 7.0—7.6 (5 H, m), and 1.50 (9 H, s) (Found: C, 63.4; H, 7.5; N, 6.7. $C_{11}H_{15}NO_3$ requires C, 63.1; H, 7.2; N, 6.7%).

Independent Preparation of Compound (2a).—A solution of *N*-phenylhydroxylamine (1.09 g, 0.01 mol) and bis(t-butylcarbonic) anhydride (Aldrich) (2.72 g, 0.05 mol) in ether (25 ml) was left at room temperature for 2 days. Evaporation and chromatography yielded (2a) (0.65 g, 31%), identical with the material obtained from the arylation described above.

t-Butyl N-*Phenoxycarbamate* (3a).—*O*-Phenylhydroxylamine [15,20] (1.09 g, 0.01 mol) and bis(t-butylcarbonic) anhydride (2.72 g, 0.0125 mol) were dissolved in ether (25 ml) and left for 2 days. Evaporation gave a dark oil which was chromatographed. Elution with chloroform and crystallization from light petroleum (b.p. 40—60 °C) gave (3a) (0.61 g, 29%), m.p. 70 °C, $\nu_{max.}$ 3 360 and 1 735 cm^{-1}; δ 8.47 (1 H, s, exchangeable with D_2O) 6.85—7.45 (5 H, m), and 1.42 (9 H, s) (Found: C, 63.0; H, 7.3; N, 6.4. $C_{11}H_{15}NO_3$ requires C, 63.1; H, 7.2; N, 6.7%).

t-Butyl N-*Methoxy*-N-*phenylcarbamate* (4a).—A solution of (2a) (0.42 g, 2 mmol) in aqueous sodium hydroxide (1N; 4 ml) was cooled to 5 °C and dimethyl sulphate (1.26 g, 2 mmol) was added. The solution was stirred for 3.5 h and extracted with ether (3 × 5 ml). Drying and evaporation gave a dark oil, which after chromatography afforded a colourless oil (0.12 g, 27%), $\nu_{max.}$ 1 720 cm^{-1}; δ 7.0—7.6 (5 H, m), 3.78 (3 H, s), and 1.58 (9 H, s) (Found: C, 64.7; H, 7.3; N, 5.95. $C_{12}H_{17}NO_3$ requires C, 64.6; H, 7.7; N, 6.3%).

t-Butyl N-*Methyl*-N-*phenoxycarbamate* (5a).—To a solution of (3a) (1.05 g, 5 mmol) in ethanolic potassium ethoxide (0.25N; 20 ml), dibenzo-18-crown-6 (100 mg) and methyl iodide (0.5 ml) were added. After being allowed to stand overnight the mixture was evaporated, water (10 ml) was added to it and the whole extracted with ether (3 × 10 ml). Drying and evaporation of the ether extract gave a semi-solid residue (0.7 g, 62%) which was crystallized from methanol–water to afford (5a) (0.7 g, 62%), m.p. 42 °C, $\nu_{max.}$ 1 715 cm^{-1}; δ 7.40—7.77 (5 H, m), 3.17 (3 H, s), and 1.38 (9 H, s) (Found: C, 64.5; H, 7.7; N, 6.0. $C_{12}H_{17}NO_3$ requires C, 64.6; H, 7.7; N, 6.3%).

Arylation of Benzyl N-*Hydroxycarbamate* (1b).—The procedure described above for the arylation of (1a) was followed to give 45% of benzyl *N*-hydroxy-*N*-phenylcarbamate (2b) m.p. 82°, identified by direct comparison with material prepared independently according to ref. 21.

Benzyl N-*Methoxy*-N-*phenylcarbamate* (4b).—Methylation of compound (2b) with dimethyl sulphate as described above for (2a) gave (4b) (69%) as a colourless oil, $\nu_{max.}$ 1 710 cm^{-1}; δ 7.38 (5 H, s), 7.0—7.6 (5 H, m), 5.30 (2 H, s), and 3.75 (3 H, s) (Found: C, 69.95; H, 6.0; N, 5.6. $C_{15}H_{15}NO_3$ requires C, 70.0; H, 5.9; N, 5.4%).

Benzyl N-*Phenoxycarbamate* (3b).—To a cooled solution of *O*-phenylhydroxylamine (1.09 g, 0.01 mol) in pyridine (5 ml), benzyl chloroformate (1.7 g, 0.01 mol) was added. After being stirred for 1 h the mixture was poured into water (20 ml) and the precipitated solid collected and crystallized from cyclohexane to give (3b) (1.97 g, 81%), m.p. 110 °C, $\nu_{max.}$ 3 170 and 1 715 cm^{-1}; δ 7.40 (5 H, s), 6.8—7.3 (5 H, m), and 5.28 (2 H, s) (Found: C, 68.9; H, 5.3; N, 5.5. $C_{14}H_{13}NO_3$ requires C, 69.1; H, 5.4; N, 5.8%).

Benzyl N-*Methyl*-N-*phenoxycarbamate* (5b).—Compound (3b) was methylated in the same manner as (3a) above, to give (5b) (60%), m.p. 91 °C after crystallization from light petroleum (b.p. 40—60 °C), $\nu_{max.}$ 1 720 cm^{-1}; δ 7.33 (5 H, s), 6.8—7.4 (5 H, m), 5.22 (2 H, s), and 3.30 (3 H, s) (Found: C, 70.2; H, 5.8; N, 5.3. $C_{15}H_{15}NO_3$ requires C, 70.0; H, 5.9; N, 5.4%).

Arylation of t-Butyl N-*Hydroxy*-N-*methylcarbamate* (6a).—To a solution of (6a) [22] (7.35 g, 0.05 mol) in ethanol (100 ml), thallium ethoxide (12.5 g, 0.05 mol) was added; a precipitate formed immediately. Diphenyliodonium bromide (18.05 g, 0.05 mol) was added to the mixture which was then refluxed with stirring for 4 h. The remaining solid (mainly unchanged iodonium salt) was filtered off and the solvent removed *in vacuo*. Water was added to the residue and the mixture was extracted with ether, which yielded a dark oil. Chromatography on silica gel gave, on elution with chloroform, first only oily materials which showed no t-butyl hydrogens in the n.m.r. spectra. Further elution with carbon tetrachloride gave a solid which was crystallized from ligroin to give 2-(N-*t-butyloxycarbonyl*-N-*methylamino*)-*phenol* (7) (1.15 g, 10%), m.p. 110 °C; $\nu_{max.}$ 3 270 and 1 655 cm^{-1}; δ 6.95—7.45 (4 H, m), 3.30 (3 H, s), and 1.53 (9 H, s) (Found: C, 64.7; H, 8.0; N, 6.4. $C_{12}H_{17}NO_3$ requires C, 64.6; H, 7.7; N, 6.3%).

2-(N-*Acetyl*-N-*methylamino*)*phenol* (9).—Compound (7) (0.22 g) in pyridine (2 ml) and acetic anhydride (0.5 ml) was left at room temperature overnight. The mixture was poured into ice–water to give an oil which solidified with time. Crystallization from methanol–water gave the *O*-acetyl derivative (8) (0.25 g, 95%), m.p. 54 °C, $\nu_{max.}$ 1 770 and 1 705 cm^{-1}; δ 6.9—7.2 (4 H, m), 3.07 (3 H, s), 2.22 (3 H, s), and 1.35 (9 H, s) (Found: C, 63.2; H, 7.2; N, 5.3. $C_{14}H_{19}NO_4$ requires C, 63.4; H, 7.4; N, 5.3%).

A solution of compound (8) (0.2 g) in trifluoroacetic acid (2 ml) was left at room temperature for 1 h and evaporated. The residue was taken up in benzene and washed with water. Removal of the solvent and crystallization from chloroform–light petroleum (b.p. 80—100 °C) gave compound (9) (0.08 g, 65%), m.p. 151 °C, identical with an authentic sample.[7]

Reaction of (6a) *with Di-*(p-*tolyl*)*iodonium Bromide*.—The preparation of the sodium salt of (6a) and its reaction with the iodonium salt in dimethyl sulphoxide were carried out as described above for the phenylation of (1a). The reaction hydrochloric acid was left overnight at room temperature. Evaporation and chromatography on silica gel (eluant benzene) gave the oximes (16) (listed in Table 1).

N-*Alkyl*-O-*phenylhydroxylamines* (16): *General Procedure*.—A methanolic solution (20 ml) of an *O*-phenyloxime (15) (0.01 mol), sodium cyanoborohydride (1 g, 0.015 mol), and a trace of Bromocresol Green was stirred at room temperature, strong acidity (ph < 4, yellow colour of the indicator) being maintained by dropwise addition of methanolic hydrogen chloride. After 3 h the solution was evaporated, water was added to the residue, and the mixture

TABLE 3

Physical and analytical data of phenyl *N*-alkylbenzohydroxamates, PhCON(R)OPh

R	M.p. (°C)	I.r. ν(C=O)/cm^{-1}	^{1}H N.m.r.[a] (δ, *J* in Hz)	Formula	Analysis (%) Found C	H	N	Required C	H	N
Me	57	1 645	3.43 (3 H, s)	$C_{14}H_{13}NO_2$	73.9	5.8	5.9	74.0	5.8	6.2
Et	Oil	1 650	3.90 (2 H, q), 1.33 (3 H, t, *J* = 7)	$C_{15}H_{15}NO_2$	74.4	6.5	6.0	74.7	6.3	5.8
Pr^i	92	1 660	4.72 (1 H, h), 1.32 (2 H, d, *J* = 7)	$C_{16}H_{17}NO_2$	75.0	7.0	5.3	75.3	6.7	5.5
cyclo-C_6H_{11}	82	1 650	4.2—4.7 (1 H, m), 0.8—2.1 (10 H, m)	$C_{19}H_{21}NO_2$	77.3	7.2	4.5	77.3	7.2	4.7
$PhCH_2$	87	1 635	5.05 (2 H, s)	$C_{20}H_{17}NO_2$	79.0	5.7	5.0	79.2	5.65	4.6

[a] Aromatic protons not included.

of (6a) (1.47 g, 0.01 mol) and the iodonium salt (3.89 g, 0.01 mol) gave 2-(N-*t-butyloxycarbonyl*-N-*methylamino*)-5-*methylphenol* (10a) (1.54 g, 65%), m.p. 129 °C, $\nu_{max.}$ 3 340 and 1 680 cm^{-1}; δ (at 60 MHz) 6.9—7.3 (3 H, m), 3.27 (3 H, s), 2.32 (3 H, s), and 1.50 (9 H, s) (Found: C, 65.7; H, 7.9; N, 6.1. $C_{13}H_{19}NO_3$ requires C, 65.8; H, 8.1; N, 5.9%).

Acetylation of (6a) was carried out in the usual manner with acetic anhydride in pyridine. The *O*-acetyl derivative had m.p. 64 °C, $\nu_{max.}$ 1 770 and 1 705 cm^{-1}; δ 7.0—7.4 (3 H, m), 3.28 (3 H, s), 2.37 (3 H, s), 2.27 (3 H, s), and 1.40 (9 H, s) (Found: C, 64.6; H, 7.4; N, 5.1. $C_{15}H_{21}NO_4$ requires C, 64.5; H, 7.6; N, 5.0%).

2-(N-*Acetyl*-N-*methylamino*)-5-*methylphenol* (10a).—(a) *From* (6a). The foregoing *O*-acetyl derivative of (6a) was treated with trifluoroacetic acid, as described for (8), to give (10a) in 70% yield, m.p. 157 °C (from cyclohexane), $\nu_{max.}$ 3 320 and 1 645 cm^{-1}; δ 6.7—7.3 (3 H, m), 3.23 (3 H, s), 2.35 (3 H, s), and 1.93 (3 H, s) (Found: C, 67.2; H, 7.2; N, 7.7. $C_{10}H_{13}NO_2$ requires C, 67.0; H, 7.3; N, 7.8%).

(b) *From* (6b). The reaction of *N*-methylacetohydroxamic acid (6b) with di-(*p*-tolyl)-iodonium bromide was carried out on the sodium salt in dimethyl sulphoxide as described for (6a). The product (10a) (59%), m.p. 157 °C, was identical with (10a) above.

2-(N-*Acetyl*-N-*methylamino*)-4-*methylphenol* (11b).—The three-step route reported [7] for the conversion of 2-aminophenol into (9) was followed without modification, starting with 2-amino-*p*-cresol. Fusion with urea, methylation with methyl sulphate, and basic hydrolysis gave 2-(methylamino)-*p*-cresol, m.p. 95 °C (Found: C, 70.3; H, 8.1; N, 10.0. $C_8H_{11}NO$ requires C, 70.0; H, 8.1; N, 10.2%).

Acetylation with one equivalent of acetyl chloride in pyridine afforded (11b), m.p. 148 °C, $\nu_{max.}$ 3 320 and 1 630 cm^{-1}; δ 6.8—7.4 (5 H, m), 3.23 (3 H, s), 2.30 (3 H, s), and 1.92 (3 H, s) (Found: C, 66.7; H, 7.5; N, 7.9. $C_{10}H_{13}NO_2$ requires C, 67.0; H, 7.3; N, 7.8%).

O-*Phenyloximes* (15).—A solution of *O*-phenylhydroxylamine (1.09 g, 0.01 mol) and an aldehyde or ketone (0.01 mol) in ethanol (20 ml) containing 1 drop of concentrated was extracted with ether. The light-brown liquids obtained upon removal of the ether were immediately used for further reactions. Spectral properties are given in Table 2.

Phenyl N *Alkylbenzohydroxamates* (17).—Benzoylation of the crude hydroxylamines (16) was carried out in the usual manner with benzoyl chloride in pyridine. The products were crystallised from ethanol–water. The oily derivative (17b) was purified by chromatography (eluant benzene). For data see Table 3.

[0/149 *Received*, 28*th January*, 1980]

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