of DNO_3, 1.32 g (4.00 mmol) of $Hg(NO_3)_2$, and 2.00 g (100 mmol) of D_2O was used to prepare $CH_3CH(OD)CHCH_3Hg^+$.

A part of the solution maintained at 0° was quickly transferred to an nmr sample tube and put in the probe of the spectrometer kept at 4.3°, with the temperature regulated by blowing cooled nitrogen gas and nmr calibrated by the relative chemical shifts of 1,3-propanediol. The redox decomposition reaction was pursued by taking spectra in sequence with a JEOL C-60 nmr spectrometer. The concentrations of oxymercurated *cis*-2-butene and methyl ethyl ketone were determined from the peak intensities by comparing them with that of the external tetramethylsilane reference. A Hitachi RMU-S mass spectrometer was used for analysis of methyl ethyl ketone produced in D_2O solution, which was separated from the solution by vacuum distillation at 0°.

Registry No.—$CH_3CH(OH)CHCH_3Hg^+$, 35184-47-5; $CH_3CH(OD)CHCH_3Hg^+$, 35184-48-6.

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A Mild and Effective Two-Step Conversion of Disubstituted Cyanamides to Secondary Amines

ARTURO DONETTI* AND ELIO BELLORA

Research Laboratories of Istituto De Angeli, 20139, Milan, Italy

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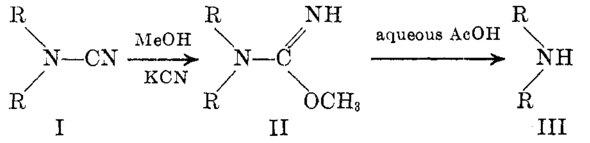
One limitation in the synthesis of secondary amines by the cyanamide method arises from the frequent difficulty of cleaving the N-CN bond.

In a previous paper,[1] we have reported on a KCN-promoted addition of methanol to disubstituted cyanamides to give isourea-type compounds (II), which could be hydrolyzed easily to secondary amines by refluxing in aqueous acetic acid.



In this manner, we were able to prepare some secondary terpenylamines not available by the usual decyanation procedures.[1,2]

This note reports further results (Table I) and experimental details from the application of this method to the synthesis of various secondary amines (including cyclic amines III-10, III-11), as well as an elucidation of the mechanism involved in the formation of the intermediate *O*-methylisoureas (II).

Satisfactory yields of disubstituted cyanamides are obtained from halides and cyanamide using sodium methylsulfinylmethide in dimethyl sulfoxide as deprotonating agent. Besides the mildness of the reaction conditions, one important advantage of this procedure over the conventional method[3] is the avoidance of isomeric products arising from allylic rearrangements or from cyclopropylcarbinyl interconversion reactions. The intermediate *O*-methylisoureas (II) are obtained by heating the corresponding cyanamides with potassium cyanide in methanol. In practice, these intermediates can be isolated, purified, and then hydrolyzed in the subsequent step, or hydrolyzed directly as crude products. The second step is carried out by refluxing the intermediates II in aqueous acetic acid. Under these conditions, the *O*-methylisoureas undergo a facile hydrolysis to secondary amines.

The formation of isoureas (II) may be regarded as a base-catalyzed addition of methanol to the cyano group, the role played by potassium cyanide being to provide a low, but sufficient, concentration of MeO^- ions.

$$CN^- + MeOH \rightleftarrows MeO^- + HCN$$

$$R_2NCN + MeO^- \longrightarrow R_2N\underset{\displaystyle OMe}{\underset{|}{C}}{=}N^- \xrightarrow{MeOH} R_2N\underset{\displaystyle OMe}{\underset{|}{C}}{=}NH + MeO^-$$

This mechanism is supported both by the successful replacement of equimolar potassium cyanide with catalytic amounts of sodium methoxide and by the analogy with the mechanism observed for the base-catalyzed conversion of nitriles to methyl imidates.[4]

The absence of strong acids or bases in the two steps makes this modification of the cyanamide method suitable to be used with sensitive substrates. Furthermore, the fact that disubstituted cyanamides are also key intermediates in the von Braun degradation suggests potential applications.[5]

Experimental Section

Boiling points are uncorrected. Melting points are uncorrected and were taken on a Büchi capillary melting point apparatus. Ir spectra were run on a Perkin-Elmer 337 spectrophotometer, nmr spectra on a Varian A-60A spectrometer (Me_4Si) (0.00 ppm).

Materials.—All the halides used for the synthesis of disubstituted cyanamides were bromides, except for 3,4,5-trimethoxybenzyl chloride and 3,4-methylenedioxybenzyl chloride. They were synthesized by known procedures. Dimethyl sulfoxide was dried by distillation from calcium hydride.

General Methods. Disubstituted Cyanamides (I).—Cyanamide (0.1 mol) was added portionwise to a stirred suspension of sodium methylsulfinylmethide[6] prepared *in situ* from 0.22 mol of a 80% dispersion of sodium hydride in mineral oil and 150 ml of dry dimethyl sulfoxide. The mixture was stirred at room temperature for 30 min and then 0.22 mol of the appropriate halide (0.11 mol for I-10 and I-11) was added slowly. Generally, the reaction temperature rose to 50–60° while a white precipitate formed. After an additional 1-hr stirring at room temperature, the mixture was poured into ice–water and extracted with ether. The ether extract was washed with water, dried over $MgSO_4$, and concentrated, and the residue was distilled or crystallized from a suitable solvent.

N,N-Disubstituted *O*-Methylisoureas (II).—A mixture of 0.1 mol of the appropriate I, 0.1 mol of potassium cyanide, and 200

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(1) A. Donetti, A. Omodei-Salè, and A. Mantegani, *Tetrahedron Lett.*, 3327 (1969); for decyanation procedures, see references therein.

(2) V. Prelog, B. C. McKusick, J. R. Merchant, S. Julia, and M. Wilhelm, *Helv. Chim. Acta*, **39**, 498 (1956); V. Cerny, L. Dolejs, and F. Sorm, *Collect. Czech. Chem. Commun.*, **29**, 1591 (1964); H. Rapoport, C. H. Lovell, H. R. Reist, and M. E. Warren, *J. Amer. Chem. Soc.*, **89**, 1942 (1967).

(3) E. B. Vliet, "Organic Syntheses," Collect. Vol. I, 2nd ed, Wiley, New York, N. Y., 1946, p 203.

(4) F. C. Schaefer and G. A. Peters, *J. Org. Chem.*, **26**, 412 (1961).

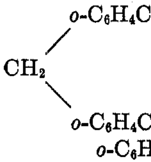
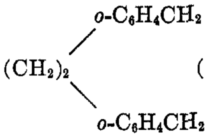
(5) Following the conditions we had previously reported,[1] Professor J. Pecher (Faculté des Sciences, Université Libre de Bruxelles) succeeded in carrying out the decyanation step during a von Braun degradation on the ajmaline molecule. Previous attempts by conventional procedures had been unsuccessful. Personal communication.

(6) R. Greenwald, M. Chaykovsky, and E. J. Corey, *J. Org. Chem.*, **28**, 1128 (1963).

TABLE I[a]

SYNTHESIS OF SECONDARY AMINES

$$\underset{\text{I}}{RRNCN} \longrightarrow \underset{\text{II}}{RRNC({=}NH)OCH_3} \longrightarrow \underset{\text{III}}{RRNH}$$

Compd[b,c]	R	Disubstituted Cyanamides (I) Mp or bp, °C (mm)	Yield, %	O-Methylisoureas (II) Mp or bp, °C (mm)	Yield, %	Secondary amines (III) Mp or bp, °C (mm)	Yield, %
1	$(CH_3)_2C{=}CHCH_2$	146–148 (15)	63	142–144 (15)	75	92–94 (15)[d]	65
2	$(CH_3)_2C{=}CHCH_2CH_2$	96–98 (0.15)	55	92–94 (0.1)	63	116–118 (14)	61
3	$(CH_3)_2C{=}CH(CH_2)_2C(CH_3){=}CHCH_2$	166–168 (0.08)	61	165–168 (0.07)	76	134–137 (0.04)[e]	60
4	$(CH_3)_2C{=}CH(CH_2)_2CH(CH_3)CH_2CH_2$	154–157 (0.05)	72	147–149 (0.03)	81	123–125 (0.03)	71
5	Cyclopropylmethyl	141–143 (15)	90	74–75 (0.07)	83	63–64 (15)	85
6	Cyclobutylmethyl	157–159 (15)	75	85–88 (0.05)	78	97–98 (15)	83
7	Benzyl	55–56[f]	88	145–147 (0.05)	90	291–292 (760)[g]	65
8	3,4,5-Trimethoxybenzyl	85–86[h]	83	106–107[h]	43	87–88[i]	60
9	3,4-Methylenedioxybenzyl	106–107[h]	85	j	89	72–73[k]	78
10	 $CH_2\begin{array}{l} / \; o\text{-}C_6H_4CH_2 \\ \backslash \; o\text{-}C_6H_4CH_2 \end{array}$ (RR)	239–240[l]	69	151–152[m]	72	124–125[n]	80
11	 $(CH_2)_2\begin{array}{l} / \; o\text{-}C_6H_4CH_2 \\ \backslash \; o\text{-}C_6H_4CH_2 \end{array}$ (RR)	127–129[o]	72	118–119[m]	70	150–152[p]	91

[a] Satisfactory analytical values (±0.4% for C, H, and N) were reported for all compounds: Ed. [b] Consistent ir and nmr spectra were obtained for all products. [c] Yields are based on distilled or crystallized products, unless otherwise specified. Purity was also checked by vpc or tlc analyses, or by comparison with the literature data, when available. [d] Lit.[7] bp 80° (10 mm). [e] Lit.[8] bp 135–137° (0.03 mm). [f] Lit.[9] mp 47–50°. [g] Lit.[10] bp 298–300°. [h] Crystallized from Et_2O. [i] Crystallized from Et_2O–petroleum ether (bp 40–70°). [j] Waxy product. [k] Lit.[11] mp 72–73°. [l] Lit.[12] mp 239–240°. [m] Recrystallized from 50% aqueous EtOH. [n] Lit.[12] mp 124.5–125°. [o] Lit.[13] mp 128–129°. [p] Lit.[13] mp 152.5°.

ml of methanol was refluxed for 24 hr. The methanol was removed, water was added to the residue, and the mixture was extracted with ether. The ether layer was washed with water, dried over $MgSO_4$, and concentrated, and the residue was purified or used as crude product in the subsequent step.

The structure of these compounds was determined by ir and nmr spectra. For instance, the ir spectrum (film) of II-1 showed absorption at 3370 (NH), 1630 (C=N), and 1270 cm^{-1} (COC). The nmr spectrum (CCl_4) had peaks at δ 1.66, 1.72 [each 6 H, s, $(CH_3)_2C{=}$], 3.63 (3 H, s, $-OCH_3$), 3.70 (4 H, d, CH_2NCH_2), 4.57 (1 H, s, =NH), 5.15 (2 H, t, 2 =CH).

Secondary Amines (III).—A solution of 0.1 mol of the appropriate II in 80% acetic acid (300 ml) was refluxed for 24 hr. The reaction mixture was allowed to cool to room temperature and was then poured into ice–water. The mixture was washed with ether, the aqueous layer was made alkaline with 10% sodium hydroxide, and the basic material was extracted with ether. The ether extract was washed with water, dried over $MgSO_4$, and concentrated, and the residue was purified (Table I).

Literature[7-13] melting points or boiling points of some of the compounds are also given in Table I.

Registry No.—I-1, 24339-01-3; I-2, 24339-02-4; I-3, 35211-92-8; I-4, 24339-03-5; I-5, 35140-75-1; I-6, 35140-76-2; I-7, 2451-91-4; I-8, 35140-78-4; I-9, 35140-79-5; I-10, 27016-63-3; I-11, 31486-22-3; II-1, 24339-04-6; II-2, 24339-05-7; II-3, 35191-83-4; II-4, 24381-82-6; II-5, 35140-84-2; II-6, 35191-85-6; II-7, 35140-85-3; II-8, 35140-86-4; II-9, 35140-87-5; II-10, 35140-88-6; II-11, 35191-86-7; III-1, 5122-42-9; III-2, 24339-06-8; III-3, 35146-71-5; III-4, 24381-83-7; III-5, 26389-68-4; III-6, 35146-74-8; III-7, 103-49-1; III-8, 35146-75-9; III-9, 6701-35-5; III-10, 16031-95-1; III-11, 31486-25-6.

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An Anomalous Reaction of Aceto-4- (or 6-) nitro-2,5-xylidides with Hydrochloric Acid

G. R. COLLINS AND S. R. RICCITIELLO*

The Dow Chemical Company, Western Division Research,
Walnut Creek, California 94598, and
Ames Research Center, NASA, Moffett Field, California 94035

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In an attempt to prepare 4-nitro- and 6-nitro-2,5-xylidine by hydrolysis of a mixture of 4-nitro- and 6-nitro-2,5-acetoxylidide,[1,2] an oil was obtained which, upon steam distillation, fractionated into two components, neither of which contained nitrogen. Only a small amount of organic tars remained as a residue in the steam distillation flask.

The major component from the oil, melting at 82–84°, gave ir and nmr spectra having absorption bands identical with those of an authentic sample of

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[2] H. Wahl, *C. R. Acad. Sci.*, **197**, 1330 (1933).